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BRUNSWICK STEAM ELECTRIC PLANT, UNIT NO. 2
DOCKET NO. 50-324/LICENSE NO. DPR-62
TRANSMITTAL OF REVISIONS TO THE CORE OPERATING LIMITS REPORT AND SUPPLEMENTAL RELOAD LICENSING REPORT

Gentlemen:

The purpose of this letter is to submit Revision 1 of the Cycle 14 Core Operating Limits Report (COLR) and Revision 1 of the Cycle 14 Supplemental Reload Licensing Report (SRLR) for the Brunswick Steam Electric Plant (BSEP), Unit No. 2. BSEP, Unit 2 Technical Specification 5.6.5.d requires that any midcycle revisions of the COLR be provided to the NRC.

The revised COLR and SRLR are being submitted due to revised operability requirements for the Main Turbine Bypass system. Revision 0 of the BSEP, Unit 2 Cycle 14 COLR specifies that with one or more bypass valves out-of-service, the Main Turbine Bypass system is considered inoperable. Revision 1 of the Unit 2 Cycle 14 COLR specifies that three or more inoperable bypass valves render the Main Turbine Bypass system inoperable. In addition, the Unit 2 Cycle 14 SRLR has been revised to address the adequacy of current operating limits with eight of ten bypass valves operable.

Please refer any questions regarding this submittal to Mr. Steven F. Tabor, Supervisor - Licensing, at (910) 457-2178.

Sincerely,

Warren J. Dorman
Manager - Regulatory Affairs
Brunswick Steam Electric Plant

A001

WRM/wrm

Enclosures:

1. Brunswick Unit 2, Cycle 14 Core Operating Limits Report, Revision 1, February 2000
2. J11-03412SRLR, Revision 1, Supplemental Reload Licensing Report for Brunswick Steam Electric Plant Unit 2 Reload 13 Cycle 14

cc (with enclosures):

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ENCLOSURE 1

BRUNSWICK STEAM ELECTRIC PLANT, UNIT NO. 2
DOCKET NO. 50-324/LICENSE NO. DPR-62
TRANSMITTAL OF REVISIONS TO THE CORE OPERATING LIMITS REPORT AND SUPPLEMENTAL RELOAD LICENSING REPORT

Brunswick Unit 2, Cycle 14
Core Operating Limits Report,
Revision 1, February 2000

BRUNSWICK UNIT 2, CYCLE 14

CORE OPERATING LIMITS REPORT

February 2000

Prepared By: ______________________ **Date:** 2/10/00
Thomas M. Dresser

Approved By: ______________________ **Date:** 2/10/00
George E. Smith
Superintendent
BWR Fuel Engineering

LIST OF EFFECTIVE PAGES

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1-2	1
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8	1
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CAUTION

References to COLR Figures or Tables should be made using titles only; figure and table numbers may change from cycle to cycle.

LIST OF TABLES

LIST OF FIGURES

Introduction and Summary

This report provides the values of the power distribution limits and control rod withdrawal block instrumentation setpoints for Brunswick Unit 2, Cycle 14 as required by TS 5.6.5.

OPERATING LIMIT	REQUIREMENT
Average Planar Linear Heat Generation Rate (APLHGR) limits (with associated core flow and core power adjustment factors)	TS 5.6.5.a.1
Minimum Critical Power Ratio (MCPR) limits (with associated core flow and core power adjustment factors)	TS 5.6.5.a.2
Allowable Values for Function 2.b of TS 3.3.1.1, APRM Flow Biased Simulated Thermal Power -High	TS 5.6.5.a.3
Allowable Values and power range setpoints for Rod Block Monitor Upscale Functions of TS 3.3.2.1	TS 5.6.5.a.4

Per TS 5.6.5.b and 5.6.5.c, these values have been determined using NRC approved methodology and are established such that all applicable limits of the plant safety analysis are met.

The limits specified in this report support single loop operation (SLO) as required by TS LCO 3.4.1 and inoperable Main Turbine Bypass System as required by TS 3.7.6.

In order to support the Thermal Hydraulic Instability (THI) E1A Stability Solution, the following is also included in this report:

OPERATING LIMIT	REQUIREMENT
Thermal Hydraulic Instability (THI) E1A Stability Solution Monitored Region and Restricted Region	TS 3.2.3 and 3.3.1.3, and TRMS 3.2
Thermal Hydraulic Instability (THI) E1A Stability Solution Exclusion Region	Implicit
"Setup" and "Non-Setup" scram values of the APRM Flow Biased Simulated Thermal Power-High Allowable Value ("Flow Biased Scram")	TS 3.2.3 and 3.3.1.1
"Setup" and "Non-Setup" control rod block values of the APRM Flow Biased - Upscale Allowable Value ("Flow Biased Rod Block")	TRMS 3.3

Four Siemens ATRIUM-10 (A10) Lead Qualification Assemblies will be loaded in the B2C14 core. Reference 4 concludes the A10 is bounded by the GE13 operating limits and licensing analyses, provided additional operating and design constraints are imposed on the GE13 fuel type used to monitor the A10. The additional operating requirements have been incorporated herein as applicable.

Preparation of this report was performed in accordance with Quality Assurance requirements as specified in Reference 1.

Single Loop Operation

Brunswick Unit 2, Cycle 14 may operate over the entire MEOD range with Single recirculation Loop Operation (SLO) as permitted by TS 3.4.1 with applicable limits specified in the COLR for TS LCO's 3.2.1, 3.2.2 and 3.3.1.1:

LCO 3.2.1, Average Planar Linear Heat Generation Rate (APLHGR) Limits: per Reference 1 and Figures 9 and 10, the APLHGR Limits include a SLO limitation of 0.8 on the MAPLHGR(F) and MAPLHGR(P) multipliers.

LCO 3.2.2, Minimum Critical Power Ratio (MCPR) Limits: per Reference 1, Table 1 and Figures 11, 11a and 12, the MCPR limits presented apply to SLO without modification.

LCO 3.3.1.1, Reactor Protection System Instrumentation Function 2.b (Average Power Range Monitors Flow Biased Simulated Thermal Power - High) Allowable Value: per Reference 1 and the THI E1A STABILITY SOLUTION, these limits apply to SLO without modification.

Inoperable Main Turbine Bypass System

Brunswick Unit 2, Cycle 14 may operate with an inoperable Main Turbine Bypass System in accordance with TS 3.7.6 with applicable limits specified in the COLR for TS LCO 3.2.1 and 3.2.2. Three or more bypass valves inoperable renders the System inoperable, although the Turbine Bypass Out-of-Service (TBPOOS) analysis supports operation with all bypass valves inoperable for the entire MEOD range and up to 110°F rated equivalent feedwater temperature reduction. The system response time assumed by the safety analyses from event initiation to start of bypass valve opening is 0.10 seconds, with at least 64% bypass flow achieved in 0.30 seconds. The applicable limits are as follows:

LCO 3.2.1, Average Planar Linear Heat Generation Rate (APLHGR) Limits: in accordance with Reference 1 as shown in Figure 10, TBPOOS requires a reduction in the MAPLGHR(P) limits between 25% and 30% power.

LCO 3.2.2, Minimum Critical Power Ratio (MCPR) Limits: in accordance with Reference 1, TBPOOS requires an increase in the MCPR(P) multiplier between 25% and 30% power, as shown in Figure 12. TBPOOS also requires increased MCPR limits, included in Table 1.

APLHGR Limits

The limiting APLHGR value for the most limiting lattice (excluding natural uranium) of each fuel type as a function of planar average exposure is given in Figures 1 through 7. These values were determined with the SAFER/GESTR LOCA methodology described in GESTAR-II (Reference 2). Figures 1 through 7 are to be used only when hand calculations are required as specified in the bases for TS 3.2.1. Hand calculated results may not match a POWERPLEX calculation since normal monitoring of the APLHGR limits with POWERPLEX uses the complete set of lattices for each fuel type provided in Reference 3.

The core flow and core power adjustment factors for use in TS 3.2.1 are presented in Figures 9 and 10. For any given flow/power state, the minimum of MAPLHGR(F) determined from Figure 9 and MAPLHGR(P) determined from Figure 10 is used to determine the governing limit.

MCPR Limits

The ODYN OPTION A, ODYN OPTION B and non-pressurization transient MCPR limits for use in TS 3.2.2 for each fuel type as a function of cycle average exposure are given in Table 1. These values were determined with the GEMINI methodology and GEXL-PLUS critical power correlation described in GESTAR-II (Reference 2) and are consistent with a Safety Limit MCPR of 1.09 specified by TS 2.1.1.2.

The core flow and core power adjustment factors for use in TS 3.2.2 are presented in Figures 11, 11a and 12. For any given power/flow state, the maximum of MCPR(F) determined from Figure 11 or 11a and MCPR(P) determined from Figure 12 is used to determine the governing limit.

All MCPR limits presented in Table 1, Figure 11, Figure 11a and Figure 12 were determined without EOC-RPT operable and apply to two recirculation pump operation and SLO without modification.

RBM Rod Block Instrumentation Setpoints

The nominal trip setpoints and allowable values of the control rod withdrawal block instrumentation for use in TS 3.3.2.1 (Table 3.3.2.1-1) are presented in Table 2. These values were determined consistent with the bases of the ARTS program and the determination of MCPR limits with the GEMINI methodology and GEXL-PLUS critical power correlation described in GESTAR-II (Reference 2).

THI E1A Stability Solution

The Enhanced Option 1A methodology was used to develop the THI E1A Stability Solution, which involves exclusion from certain areas of the power/flow map and specific restrictions for operating in other areas.

The COLR provides the Stability Regions on the power/(core) flow map in Figures 13-16. These Figures define the Monitored and Restricted Regions for compliance with TS 3.2.3, TS 3.3.1.3 and TRMS 3.2 (and indirectly TS 3.3.1.1 and TRMS 3.3), and include the Exclusion Region (for which definition in the COLR is not a TS requirement). Core flow nominal trip setpoint values on Figures 13-16 correspond to the nominal trip setpoint values translated into drive flow and installed in the Flow Control Trip Reference (FCTR) cards.

Automatic features of the THI E1A Stability Solution implementation use digital FCTR cards that incorporate Trip Reference setpoints which are equivalent or more restrictive than the pre-Stability Solution APRM flow-biased and clamped limits. The FCTR cards support TS 3.3.1.1 (automatic APRM Flow-biased Scram) and TRMS 3.2 (Restricted Region Entry Alarm, which uses the TRMS 3.3 Flow-biased Rod Block setpoint). Figures 17-20, E1A Setpoint Allowable Values Versus Aligned Drive Flow, are based on drive flow and not core flow to support the flow signal used for the FCTR cards. Also, Figures 17-20 allow quantification of Technical Specification compliance once the drive flow input is aligned in accordance with Table 3.

"Non-Setup" setpoints (Figures 13, 15, 17, 19) enforce the normal Exclusion and Restricted Regions described above. Setup setpoints (Figures 14, 16, 18, 20) are to be used only when FCBB $\leq$ 1.0 and allow operation in the Restricted Region. When operating in Setup, the Flow-biased Rod Block setpoints generally increase in power to the Flow-biased Scram or power/flow map boundaries. The Flow-biased Scram setpoint generally increases by an equivalent amount (within the power/flow map boundaries) to avoid spurious scrams from power spikes. The inherent stability from maintaining FCBB less than one justifies continued operation in the Restricted Region, but not in that portion of the power/flow map which, in Setup, becomes unprotected by the Flow-biased Scram. The alarm associated with the Rod Block ceases to be a RREA when in Setup, but signals to Operations a similar need to immediately move to a more stable region of the power/flow map.

For BNP the two loop operation (TLO) Flow-biased Scram and Rod Block setpoints, and TLO Stability Regions, are equivalent to the SLO counterparts over all applicable portions of the operating domain.

The E1A Stability Solution provides for distinct Flow-biased Scram and Rod Block setpoints for normal and reduced feedwater temperature conditions ("normal" and "alternate" setpoints) because the core is more susceptible to instabilities with decreasing feedwater temperature. Normal setpoints (Figures 13, 14, 17, 18) are to be used below 30% power or when feedwater temperature is within 50°F rated equivalent of nominal. Alternate setpoints (Figures 15, 16 19, 20) are to be used above 30% power when feedwater is reduced by more than 50°F rated equivalent (50°F * (% power/100)$^{0.385}$) in accordance with 2OP-32.

References

1) BNP Design Calculation 2B21-0554; "Preparation of the B2C14 Core Operating Limits Report," Revision 1, February 2000.

2) NEDE-24011-P-A; "General Electric Standard Application for Reactor Fuel," (latest approved version).

3) NEDC-31624P, "Loss-of-Coolant Accident Analysis Report for Brunswick Steam Electric Plant Unit 2 Reload 13 Cycle 14," Supplement 2, Revision 6, February 1999.

4) EMF-2168(P), "Brunswick ATRIUM-10 Lead Qualification Assemblies Safety Analysis," Revision 0, March 1999.

Table 1

MCPR Limits

(EOC-RPT Not Required)

Steady State, Non-pressurization Transient MCPR Limits	
Fuel Type	Exposure Range: BOC - EOC
GE13	1.29
A10	1.43

Pressurization Transient MCPR Limits, OLMCPR (100%P): Turbine Bypass System Operable			
		Normal and Reduced Feedwater Temperature	
		Exposure Range:	Exposure Range:
MCPR Option	**Fuel Type**	BOC to EOFPC-2205 MWd/MT	EOFPC-2205 MWd/MT to EOC
A	GE13	1.39	1.46
	A10	1.55	1.62
B	GE13	1.34	1.38
	A10	1.49	1.53

Pressurization Transient MCPR Limits, OLMCPR (100%P): Turbine Bypass System Inoperable		
		Normal and Reduced Feedwater Temperature
MCPR Option	**Fuel Type**	BOC to EOC
A	GE13	1.48
	A10	1.65
B	GE13	1.40
	A10	1.56

This Table is referred to by Technical Specifications 3.2.2, 3.4.1 and 3.7.6.

Table 2

RBM System Setpoints

Setpoint	Trip Setpoint	Allowable Value
Lower Power Setpoint (LPSP[a])	27.0	≤ 29.0
Intermediate Power Setpoint (IPSP[a])	62.0	≤ 64.0
High Power Setpoint (HPSP[a])	82.0	≤ 84.0
Low Trip Setpoint (LTSP[b])	≤ 115.1	≤ 115.5
Intermediate Trip Setpoint (ITSP[b])	≤ 109.3	≤ 109.7
High Trip Setpoint (HTSP[b])	≤ 105.5	≤ 105.9
t_{d2}	≤ 2.0 seconds	≤ 2.0 seconds

[a] Setpoints in percent of Rated Thermal Power.

[b] Setpoints relative to a full scale reading of 125. For example, ≤ 115.1 means ≤ 115.1/125.0 of full scale.

This Table is referred to by Technical Specification 3.3.2.1 (Table 3.3.2.1-1).

Table 3

Aligned Drive Flow

The Scram and Rod Block trip setpoints are provided by Flow Control Trip Reference (FCTR) cards. The FCTR cards have their drive flows calibrated each cycle by 0PT-50.10, "APRM FCTR Card Drive Flow Alignment". The calibration "aligns" the current cycle drive flow to the drive flow used when the E1A flow mapping solution was developed for BNP. The COLR presents the Scram and Rod Block trip setpoints as a function of aligned drive flow. This table provides an equation for deriving the aligned drive flow from the FCTR card input drive flow signal:

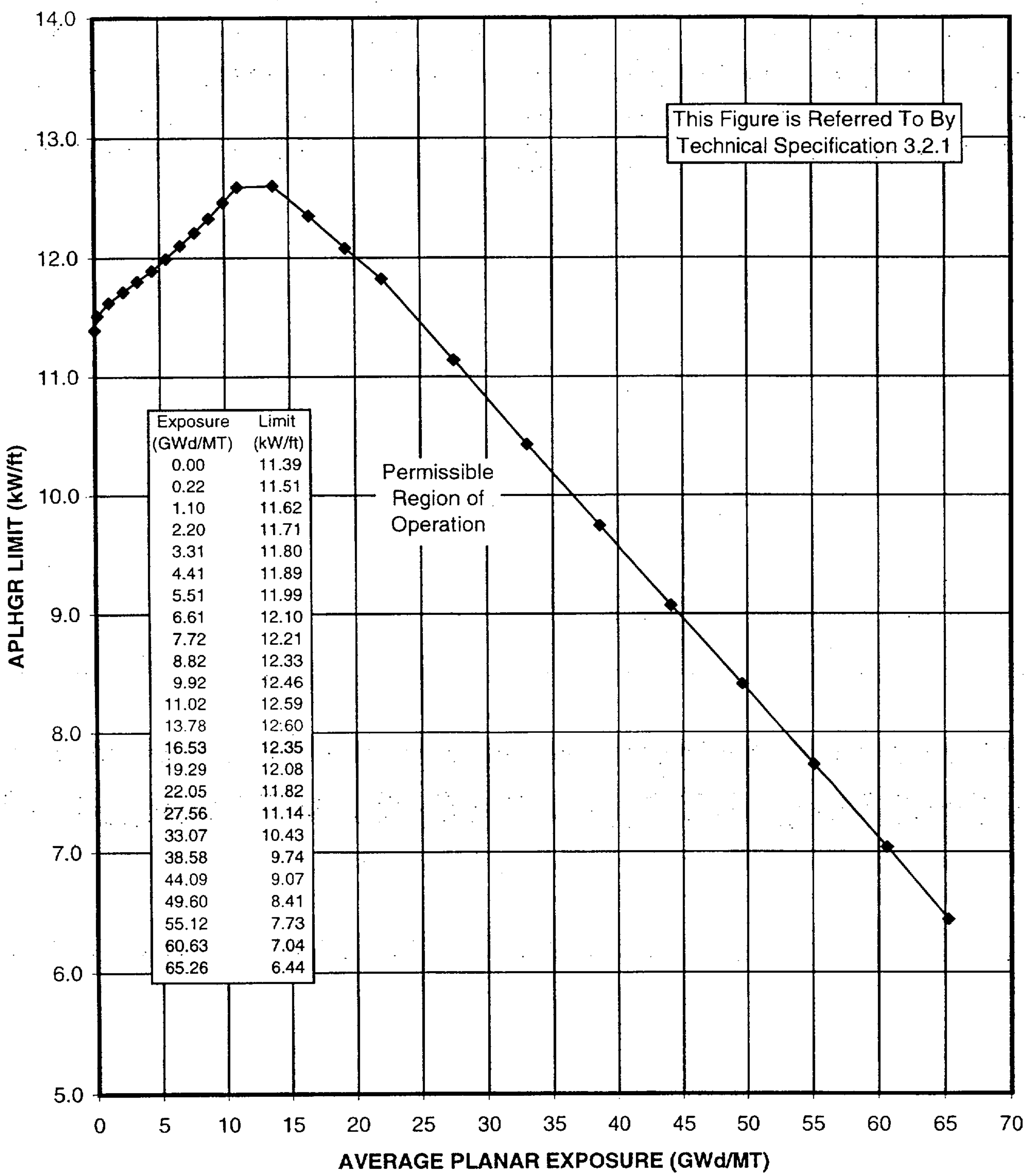
$$W_D = \frac{100.005 \cdot \Delta^{40} - 30.294 \cdot \Delta^{100} + 69.711 \cdot W_{\tilde{D}}}{69.711 - (\Delta^{100} - \Delta^{40})}$$

where:
W_D is the aligned drive flow to be used for Figures 17 through 20
Δ^{40} and Δ^{100} are the current values for the FCTR card alignment
$W_{\tilde{D}}$ is the input drive flow signal

This Table supports Technical Specifications 3.2.3 and 3.3.1.1 and Technical Requirements Manual Specifications 3.2 and 3.3.

Figure 1

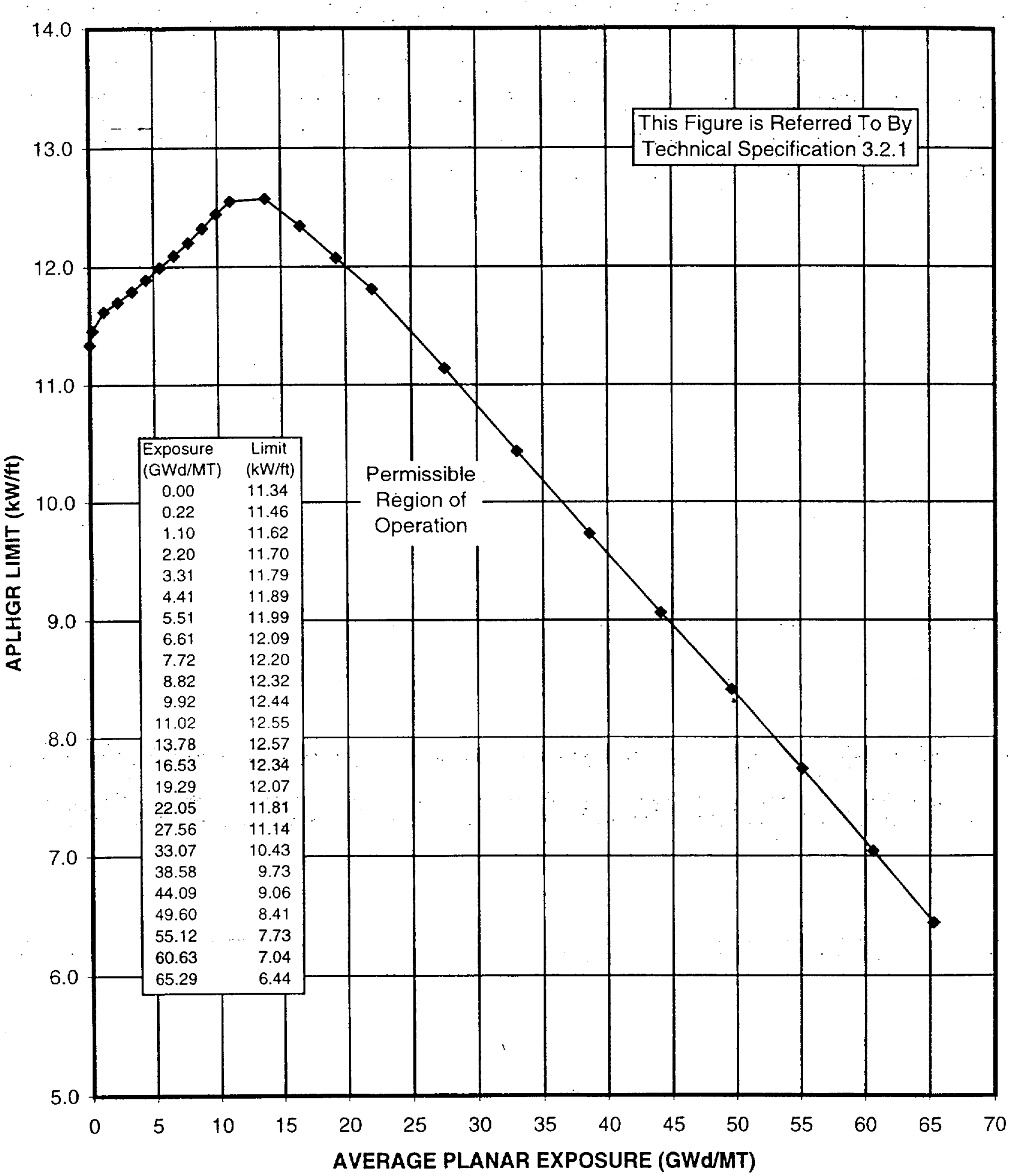
Fuel Type GE13-P9DTB363-11GZ-100T-146-T (GE13)
Average Planar Linear Heat Generation Rate (APLHGR) Limit
Versus Average Planar Exposure



Exposure (GWd/MT)	Limit (kW/ft)
0.00	11.39
0.22	11.51
1.10	11.62
2.20	11.71
3.31	11.80
4.41	11.89
5.51	11.99
6.61	12.10
7.72	12.21
8.82	12.33
9.92	12.46
11.02	12.59
13.78	12.60
16.53	12.35
19.29	12.08
22.05	11.82
27.56	11.14
33.07	10.43
38.58	9.74
44.09	9.07
49.60	8.41
55.12	7.73
60.63	7.04
65.26	6.44

Figure 2

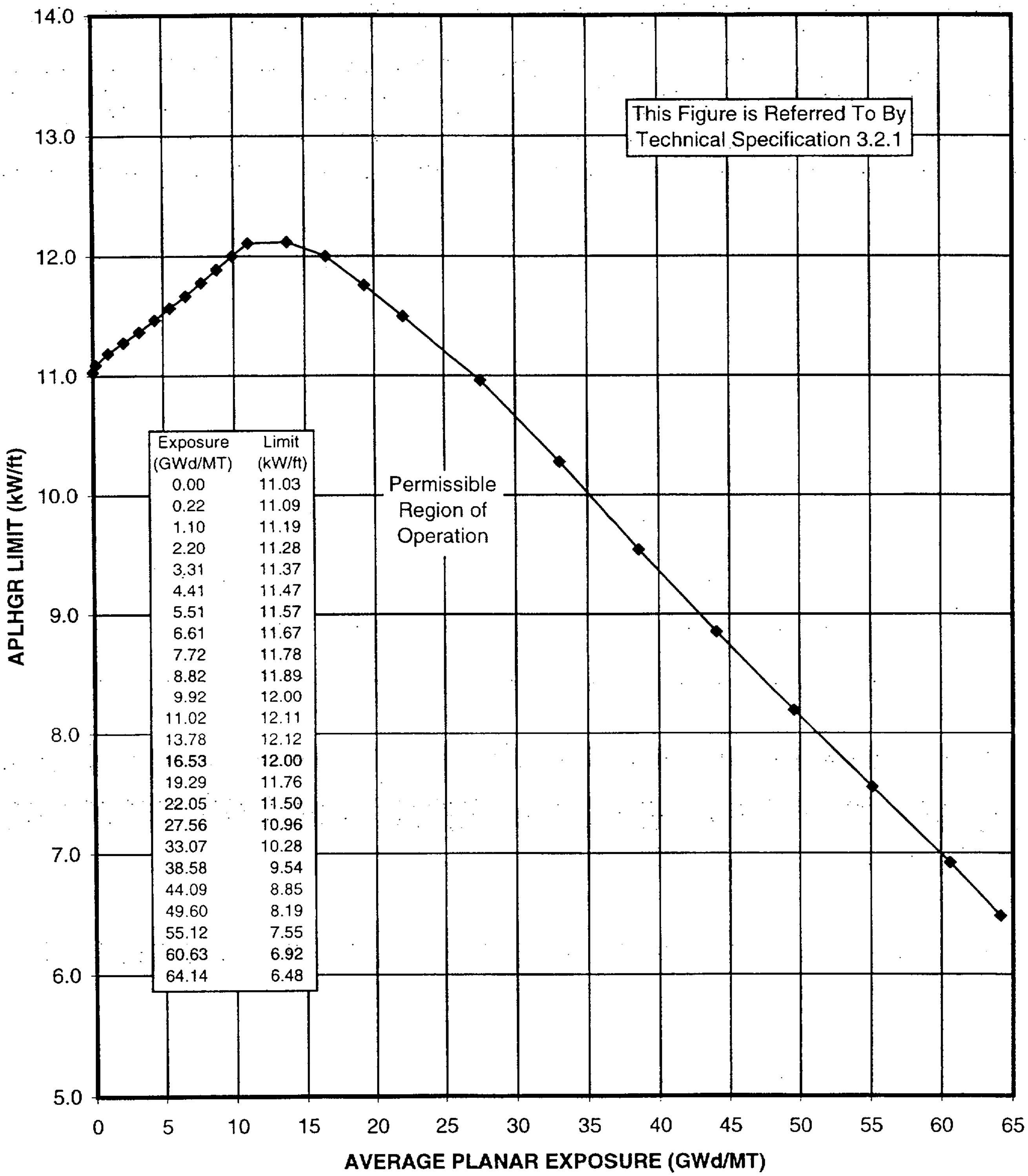
Fuel Type GE13-P9DTB363-11GZ1-100T-146-T (GE13) Average Planar Linear Heat Generation Rate (APLHGR) Limit Versus Average Planar Exposure



Exposure (GWd/MT)	Limit (kW/ft)
0.00	11.34
0.22	11.46
1.10	11.62
2.20	11.70
3.31	11.79
4.41	11.89
5.51	11.99
6.61	12.09
7.72	12.20
8.82	12.32
9.92	12.44
11.02	12.55
13.78	12.57
16.53	12.34
19.29	12.07
22.05	11.81
27.56	11.14
33.07	10.43
38.58	9.73
44.09	9.06
49.60	8.41
55.12	7.73
60.63	7.04
65.29	6.44

Figure 3

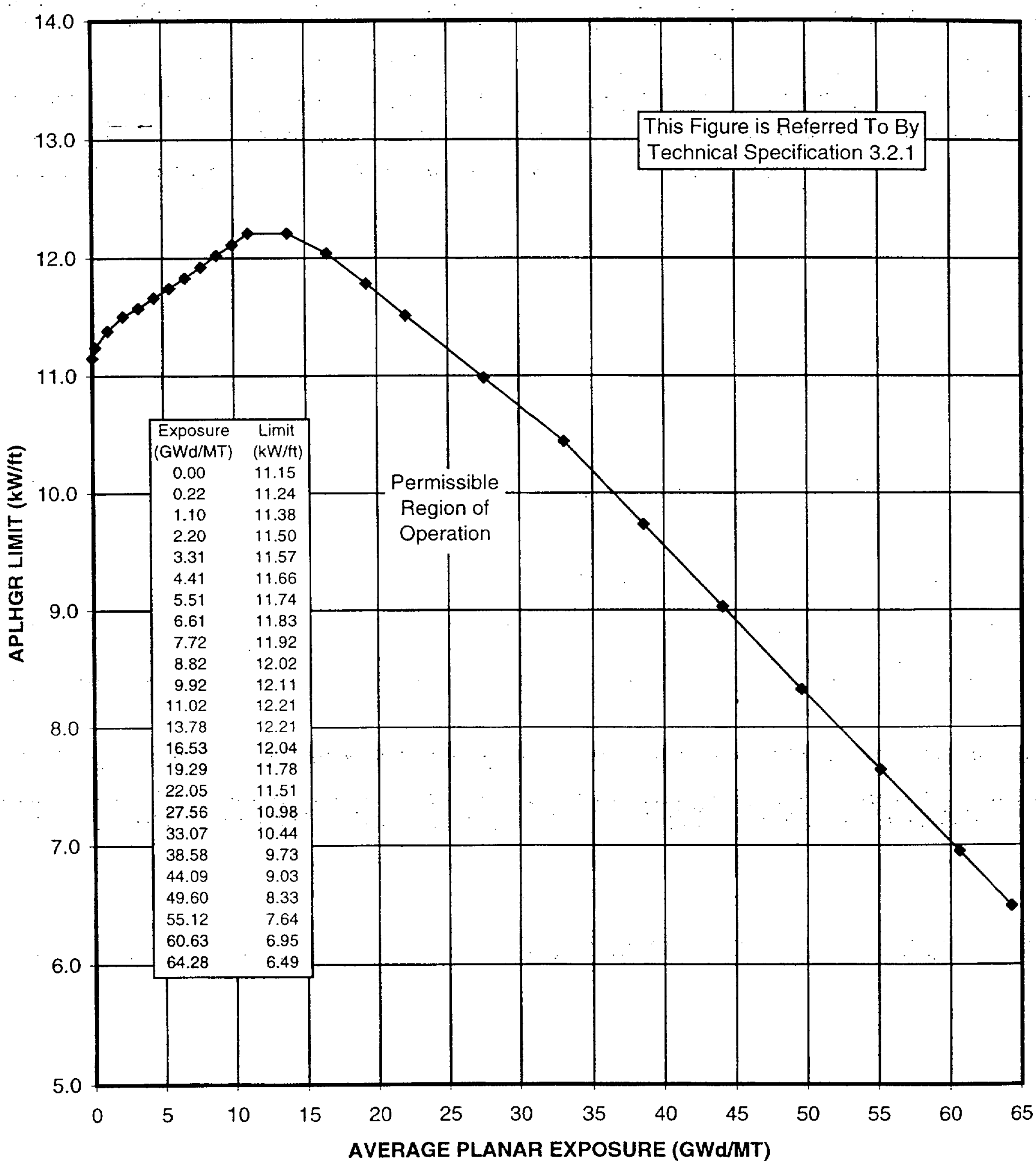
Fuel Type GE13-P9DTB393-4G6.0/9G5.0-100T-146-T (GE13) Average Planar Linear Heat Generation Rate (APLHGR) Limit Versus Average Planar Exposure



Exposure (GWd/MT)	Limit (kW/ft)
0.00	11.03
0.22	11.09
1.10	11.19
2.20	11.28
3.31	11.37
4.41	11.47
5.51	11.57
6.61	11.67
7.72	11.78
8.82	11.89
9.92	12.00
11.02	12.11
13.78	12.12
16.53	12.00
19.29	11.76
22.05	11.50
27.56	10.96
33.07	10.28
38.58	9.54
44.09	8.85
49.60	8.19
55.12	7.55
60.63	6.92
64.14	6.48

Figure 4

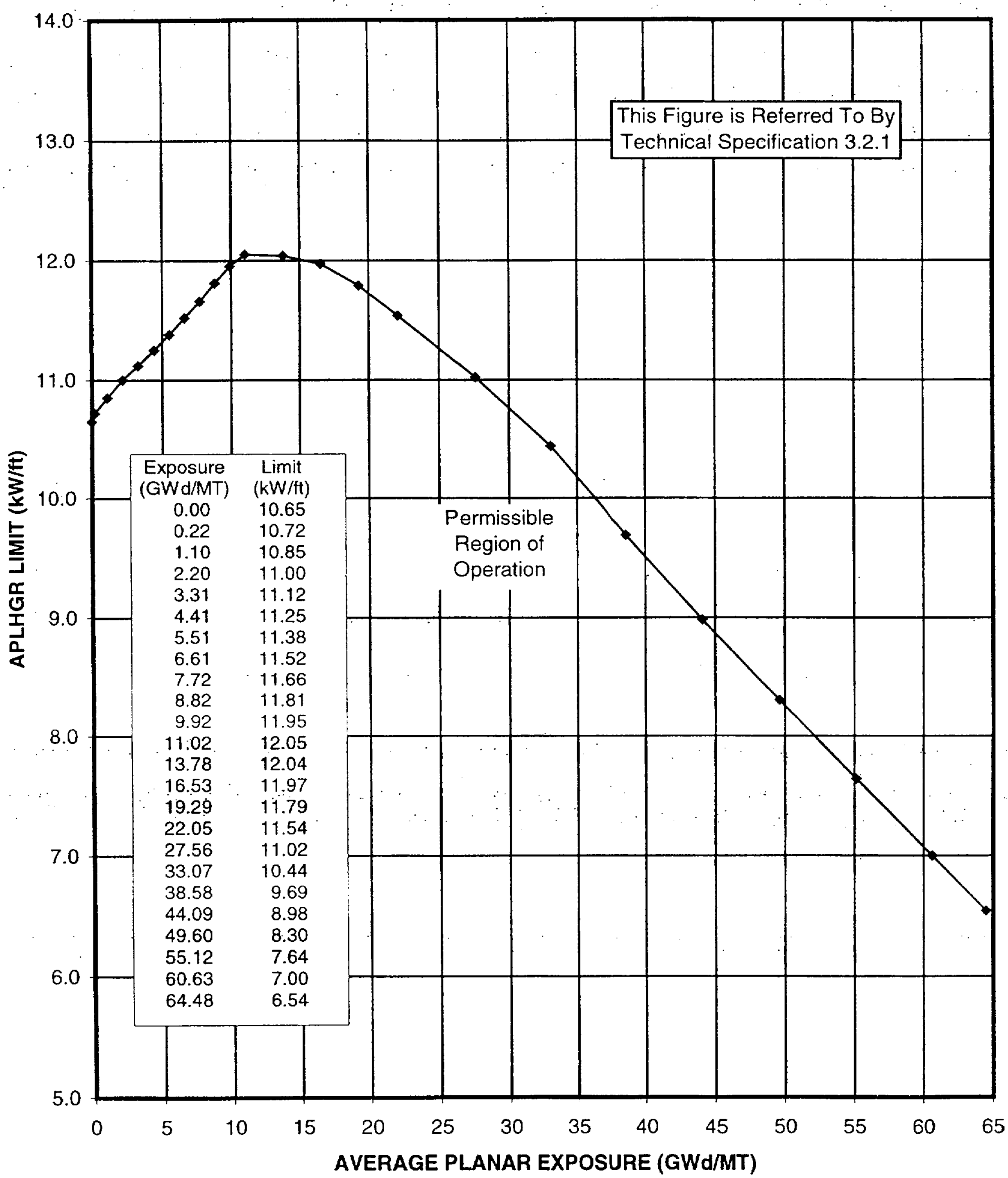
Fuel Type GE13-P9DTB395-12G5.0-100T-146-T (GE13)
Average Planar Linear Heat Generation Rate (APLHGR) Limit
Versus Average Planar Exposure



Exposure (GWd/MT)	Limit (kW/ft)
0.00	11.15
0.22	11.24
1.10	11.38
2.20	11.50
3.31	11.57
4.41	11.66
5.51	11.74
6.61	11.83
7.72	11.92
8.82	12.02
9.92	12.11
11.02	12.21
13.78	12.21
16.53	12.04
19.29	11.78
22.05	11.51
27.56	10.98
33.07	10.44
38.58	9.73
44.09	9.03
49.60	8.33
55.12	7.64
60.63	6.95
64.28	6.49

Figure 5

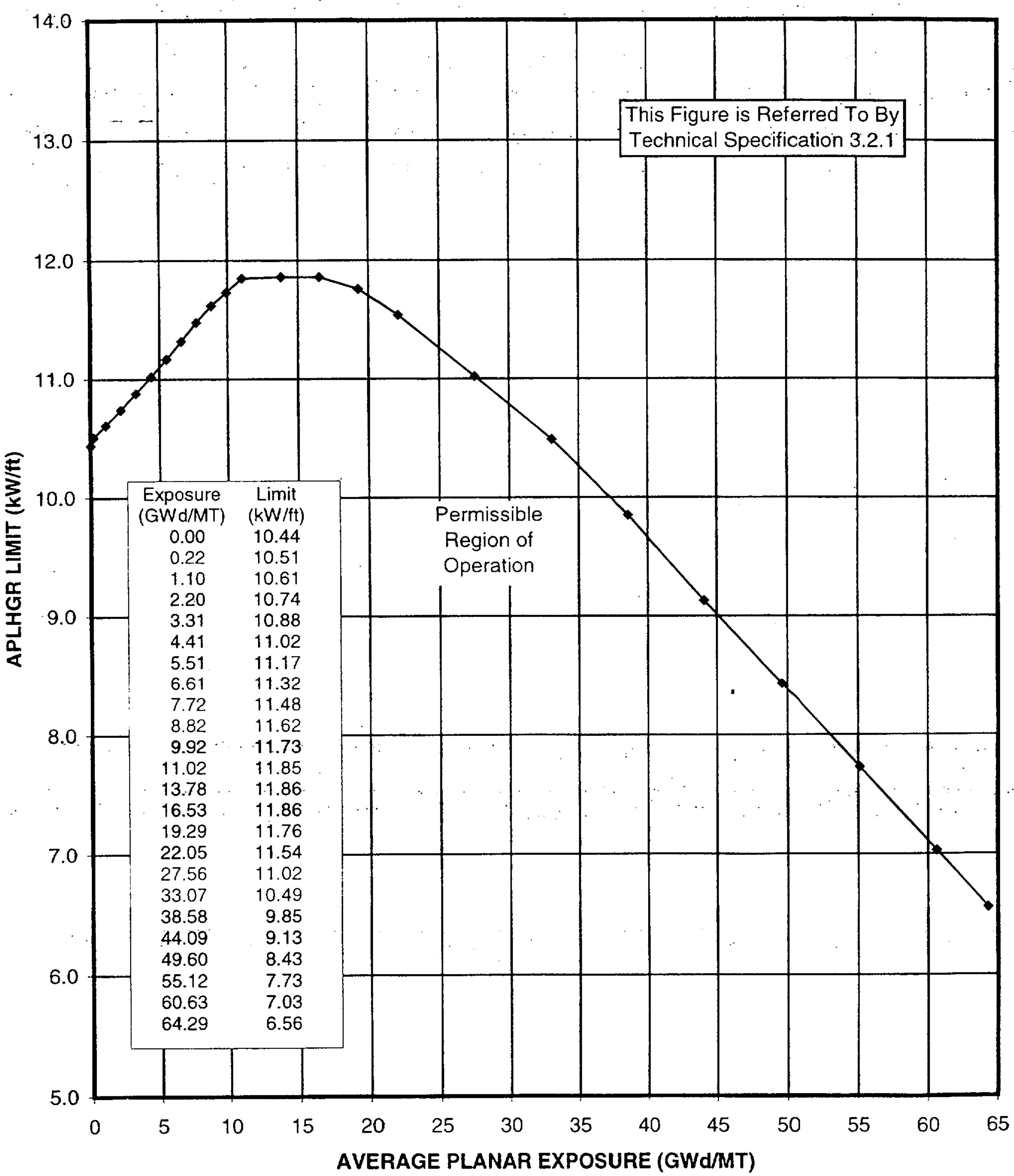
Fuel Type GE13-P9DTB403-5G6.0/7G5.0-100T-146-T (GE13) Average Planar Linear Heat Generation Rate (APLHGR) Limit Versus Average Planar Exposure



Exposure (GWd/MT)	Limit (kW/ft)
0.00	10.65
0.22	10.72
1.10	10.85
2.20	11.00
3.31	11.12
4.41	11.25
5.51	11.38
6.61	11.52
7.72	11.66
8.82	11.81
9.92	11.95
11.02	12.05
13.78	12.04
16.53	11.97
19.29	11.79
22.05	11.54
27.56	11.02
33.07	10.44
38.58	9.69
44.09	8.98
49.60	8.30
55.12	7.64
60.63	7.00
64.48	6.54

Figure 6

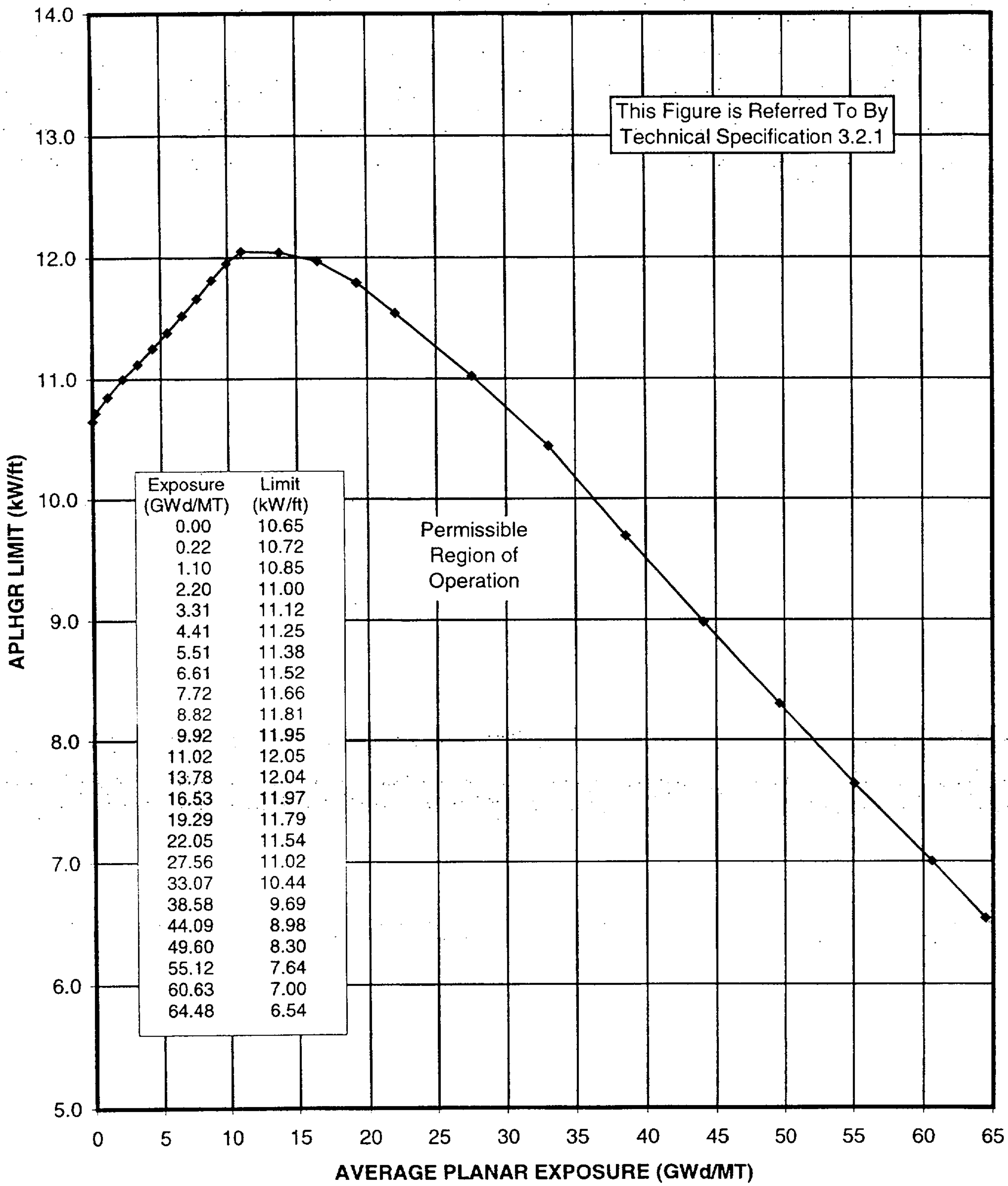
Fuel Type GE13-P9DTB403-7G6.0/7G5.0-100T-146-T (GE13) Average Planar Linear Heat Generation Rate (APLHGR) Limit Versus Average Planar Exposure



Exposure (GWd/MT)	Limit (kW/ft)
0.00	10.44
0.22	10.51
1.10	10.61
2.20	10.74
3.31	10.88
4.41	11.02
5.51	11.17
6.61	11.32
7.72	11.48
8.82	11.62
9.92	11.73
11.02	11.85
13.78	11.86
16.53	11.86
19.29	11.76
22.05	11.54
27.56	11.02
33.07	10.49
38.58	9.85
44.09	9.13
49.60	8.43
55.12	7.73
60.63	7.03
64.29	6.56

Figure 7

Fuel Type Atrium-10
Average Planar Linear Heat Generation Rate (APLHGR) Limit Versus Average Planar Exposure



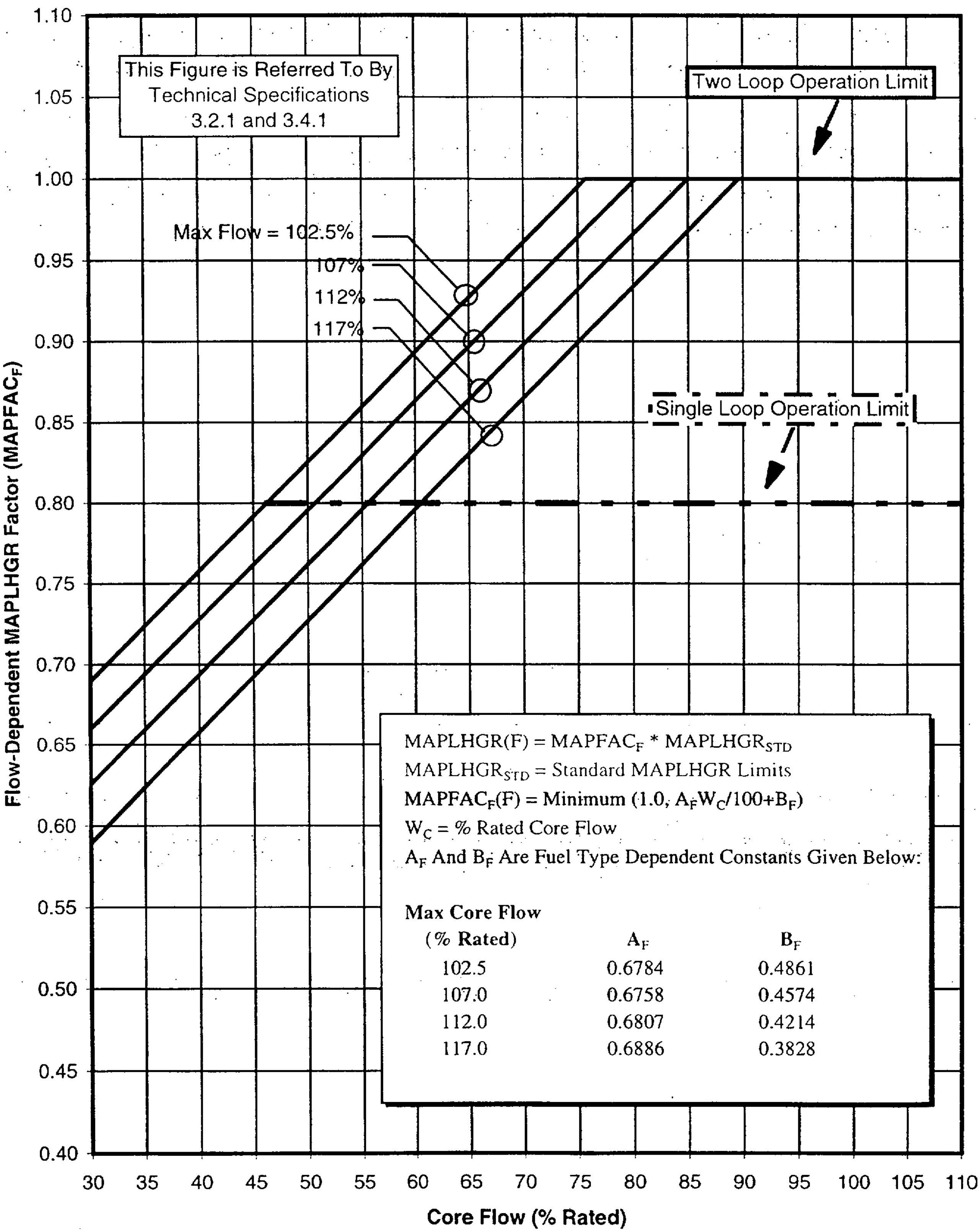
Exposure (GWd/MT)	Limit (kW/ft)
0.00	10.65
0.22	10.72
1.10	10.85
2.20	11.00
3.31	11.12
4.41	11.25
5.51	11.38
6.61	11.52
7.72	11.66
8.82	11.81
9.92	11.95
11.02	12.05
13.78	12.04
16.53	11.97
19.29	11.79
22.05	11.54
27.56	11.02
33.07	10.44
38.58	9.69
44.09	8.98
49.60	8.30
55.12	7.64
60.63	7.00
64.48	6.54

Figure 8

Not Used

Figure 9

Flow-Dependent MAPLHGR Limit, MAPLHGR(F)



MAPLHGR(F) = $MAPFAC_F$ * $MAPLHGR_{STD}$

$MAPLHGR_{STD}$ = Standard MAPLHGR Limits

$MAPFAC_F(F)$ = Minimum $(1.0, A_F W_C/100+B_F)$

W_C = % Rated Core Flow

A_F And B_F Are Fuel Type Dependent Constants Given Below:

Max Core Flow (% Rated)	A_F	B_F
102.5	0.6784	0.4861
107.0	0.6758	0.4574
112.0	0.6807	0.4214
117.0	0.6886	0.3828

Figure 10

Power-Dependent MAPLHGR Limit, MAPLHGR (P)

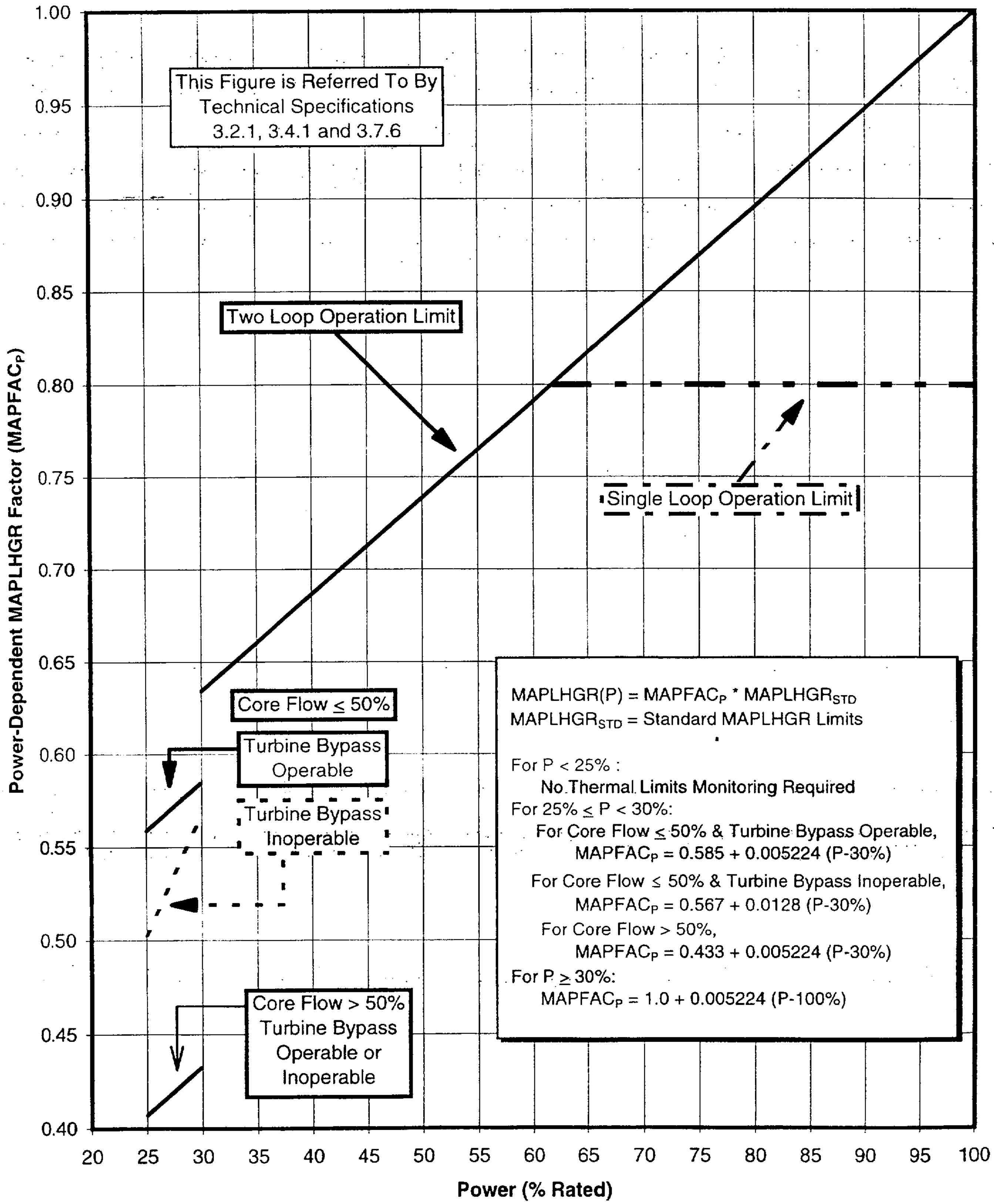


Figure 11

GE13 Flow-Dependent MCPR Limit, MCPR(F)

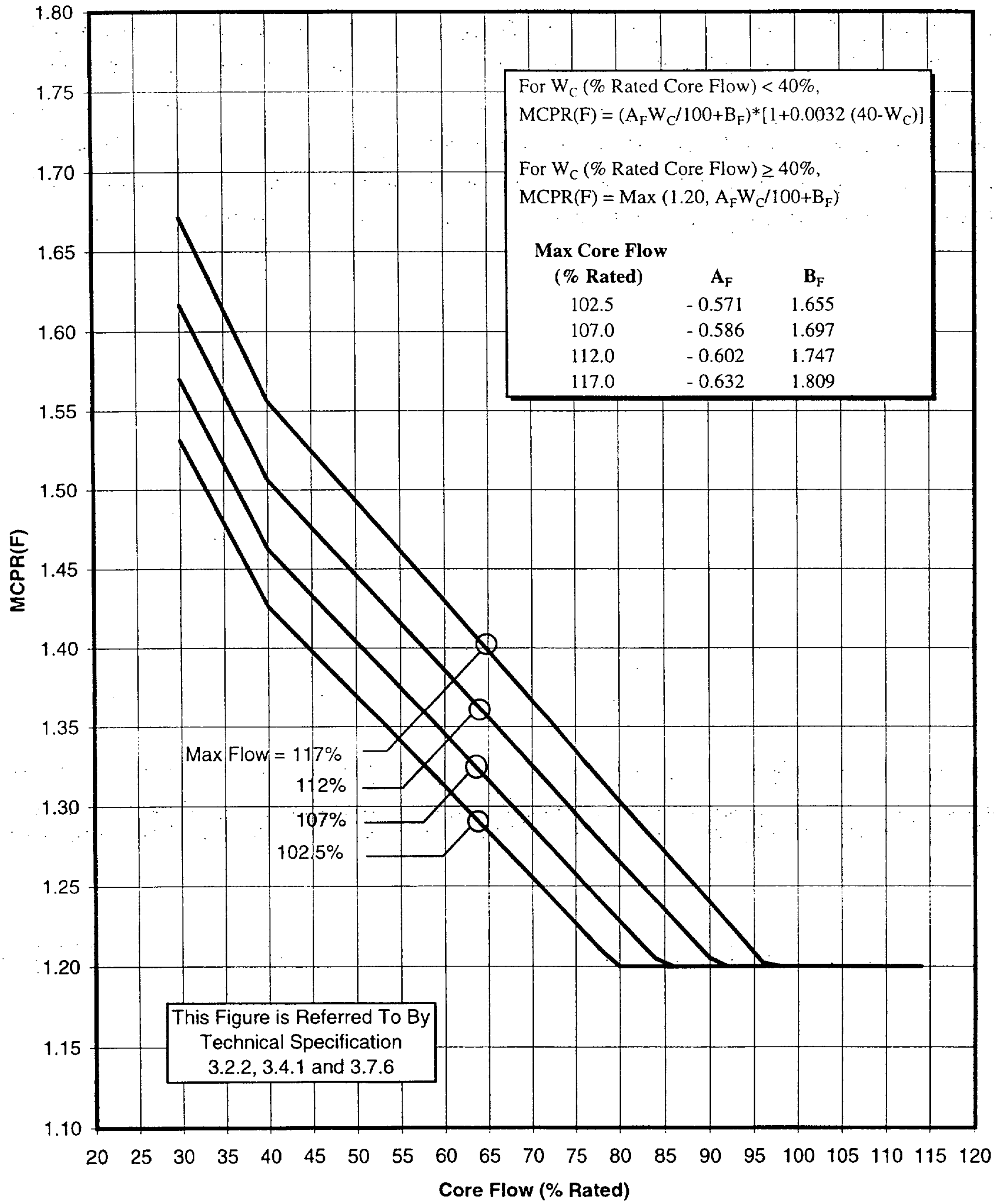


Figure 11a

A10 Flow-Dependent MCPR Limit, MCPR(F)

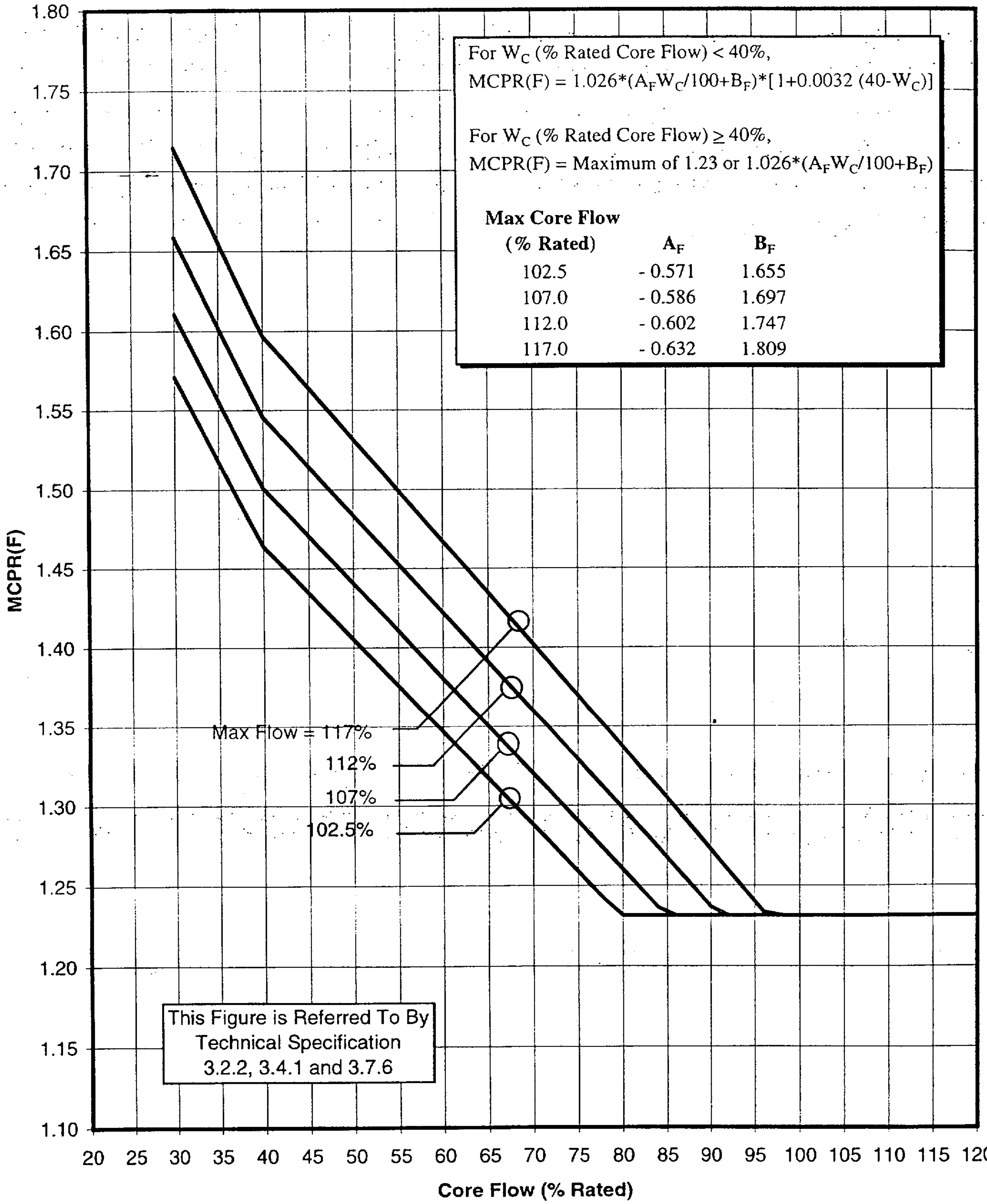


Figure 12

Power - Dependent MCPR Limit, MCPR (P)

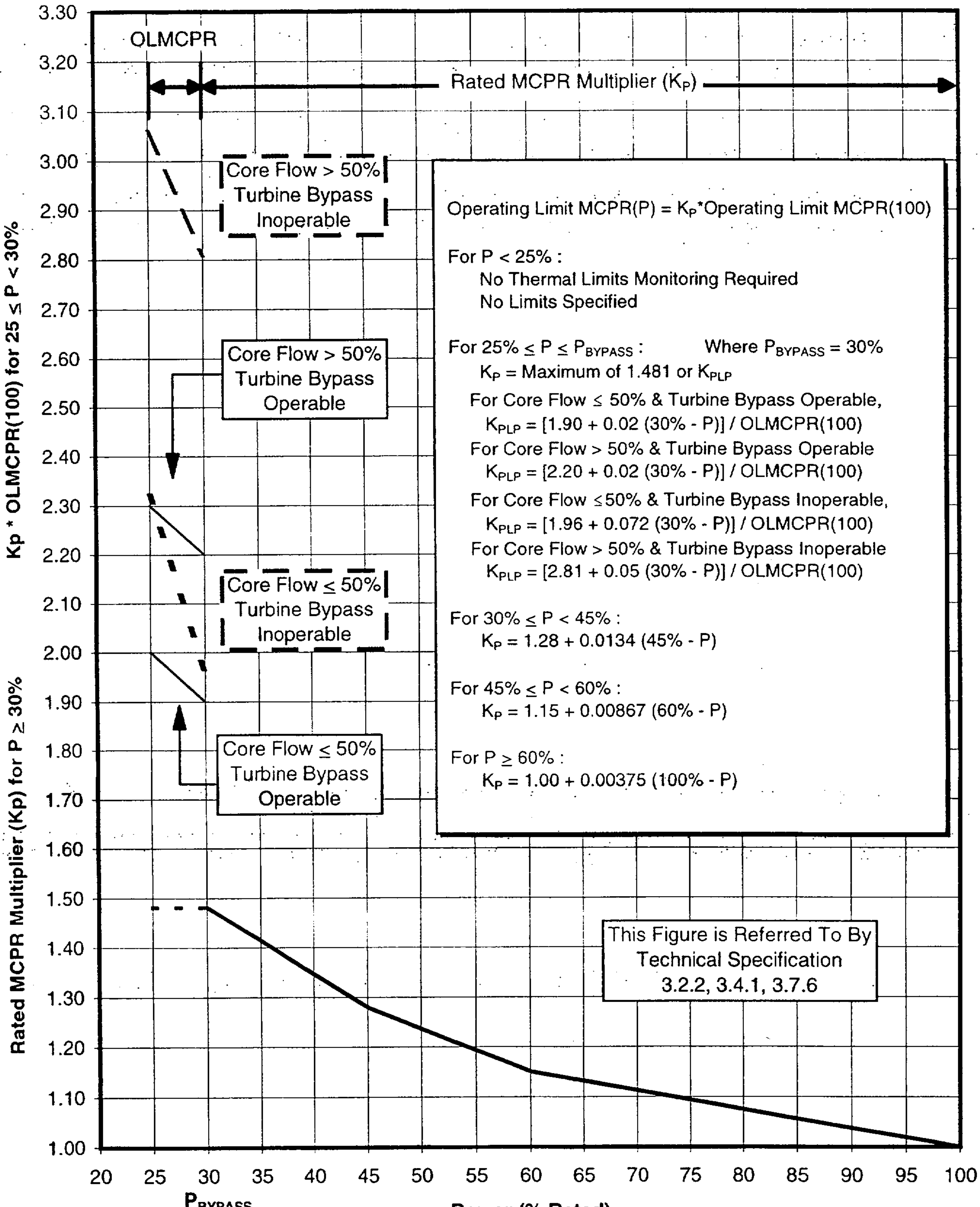
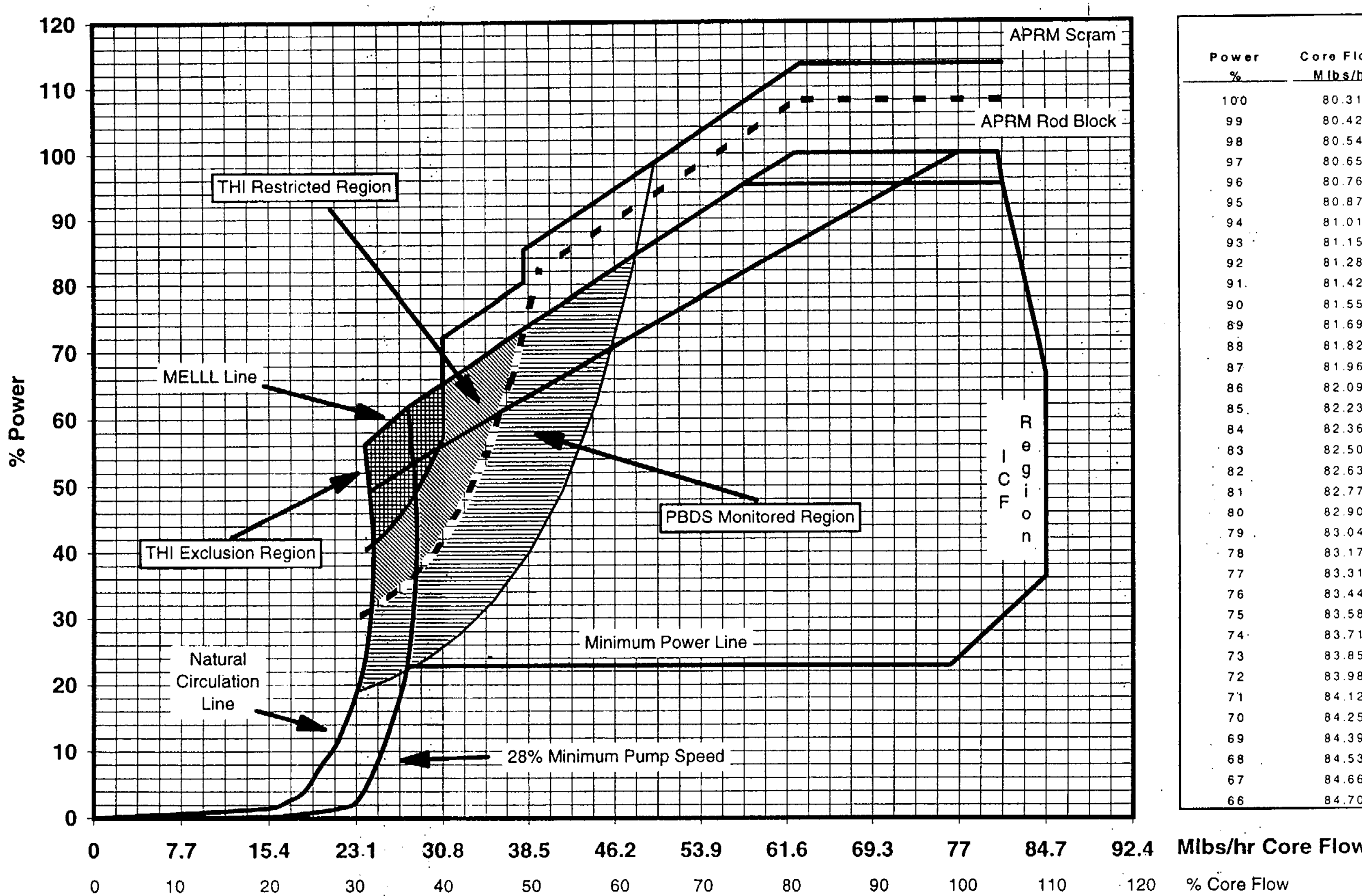


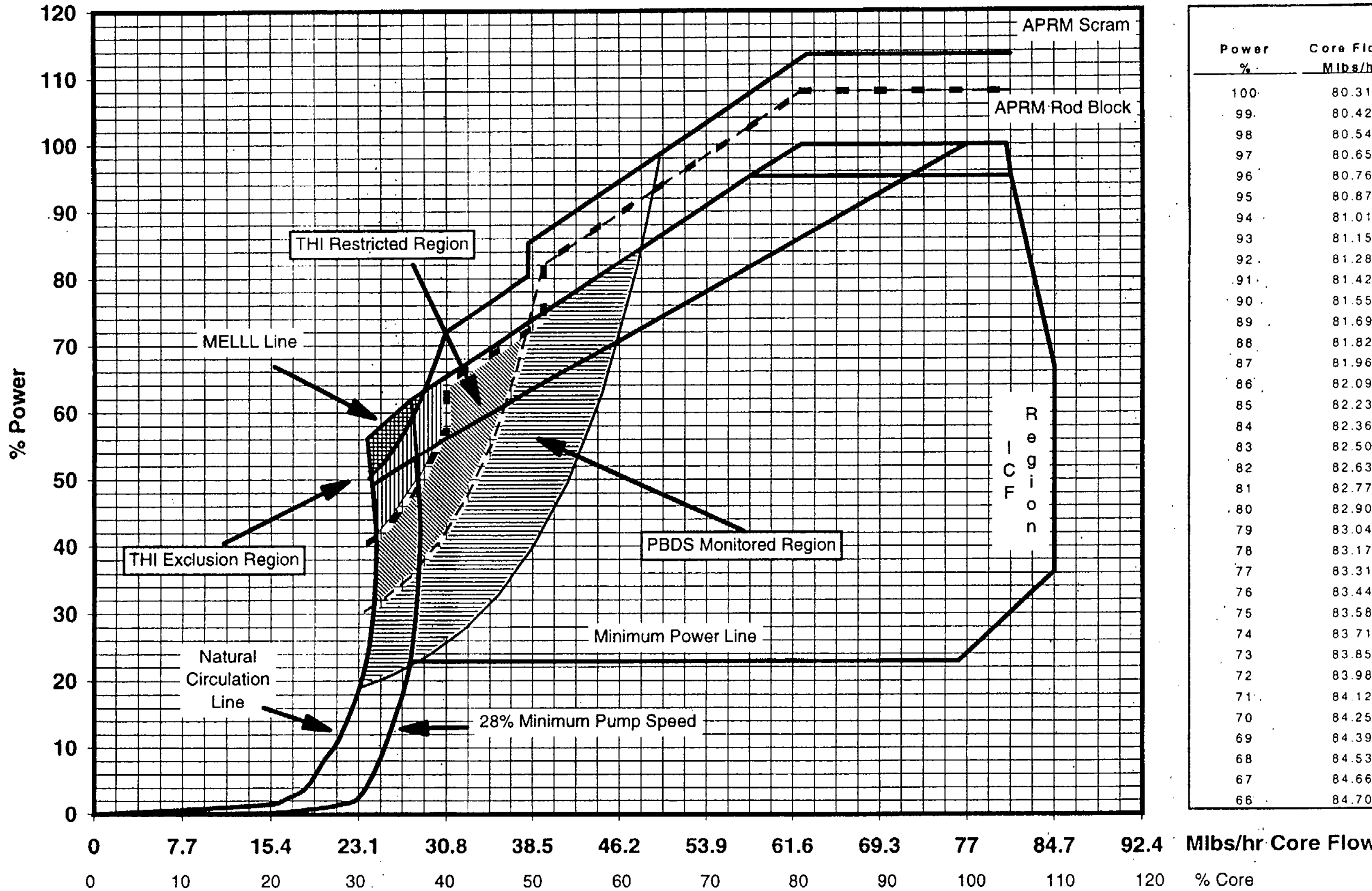
Figure 13
Power/Flow Map Stability Regions: Normal TFW, Non-Setup



Power %	Core Flow, Mlbs/hr
100	80.31
99	80.42
98	80.54
97	80.65
96	80.76
95	80.87
94	81.01
93	81.15
92	81.28
91.	81.42
90	81.55
89	81.69
88	81.82
87	81.96
86	82.09
85.	82.23
84	82.36
83	82.50
82	82.63
81	82.77
80	82.90
79	83.04
78	83.17
77	83.31
76	83.44
75	83.58
74	83.71
73	83.85
72	83.98
71	84.12
70	84.25
69	84.39
68	84.53
67	84.66
66	84.70

This Figure supports Technical Specifications 3.2.3, 3.3.1.1 and 3.3.1.3 and the Technical Requirements Manual Specifications 3.2 and 3.3

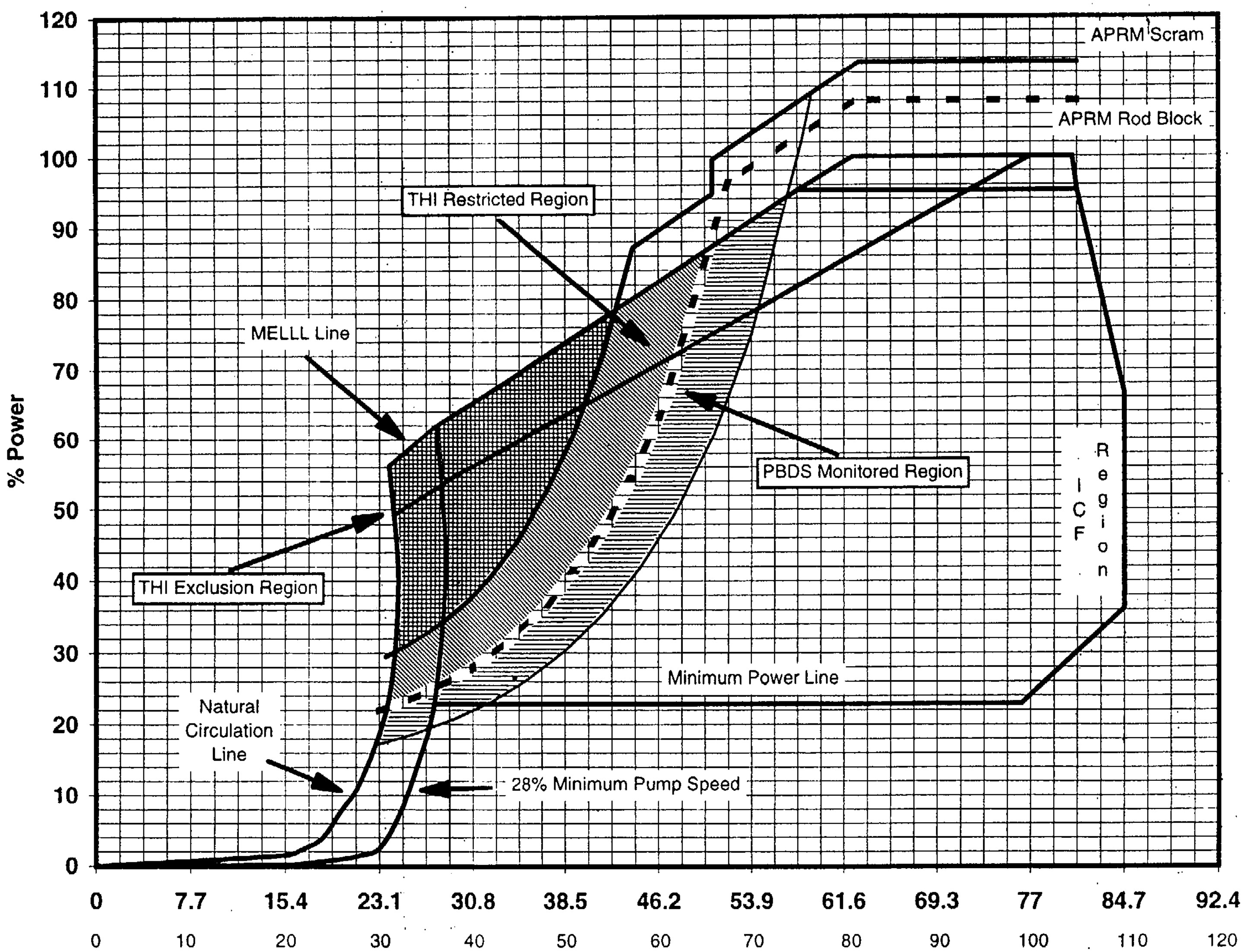
Figure 14
Power/Flow Map Stability Regions: Normal TFW, Setup



Power %	Core Flow, Mlbs/hr
100	80.31
99	80.42
98	80.54
97	80.65
96	80.76
95	80.87
94	81.01
93	81.15
92	81.28
91	81.42
90	81.55
89	81.69
88	81.82
87	81.96
86	82.09
85	82.23
84	82.36
83	82.50
82	82.63
81	82.77
80	82.90
79	83.04
78	83.17
77	83.31
76	83.44
75	83.58
74	83.71
73	83.85
72	83.98
71	84.12
70	84.25
69	84.39
68	84.53
67	84.66
66	84.70

This Figure supports Technical Specifications 3.2.3, 3.3.1.1 and 3.3.1.3 and the Technical Requirements Manual Specifications 3.2 and 3.3

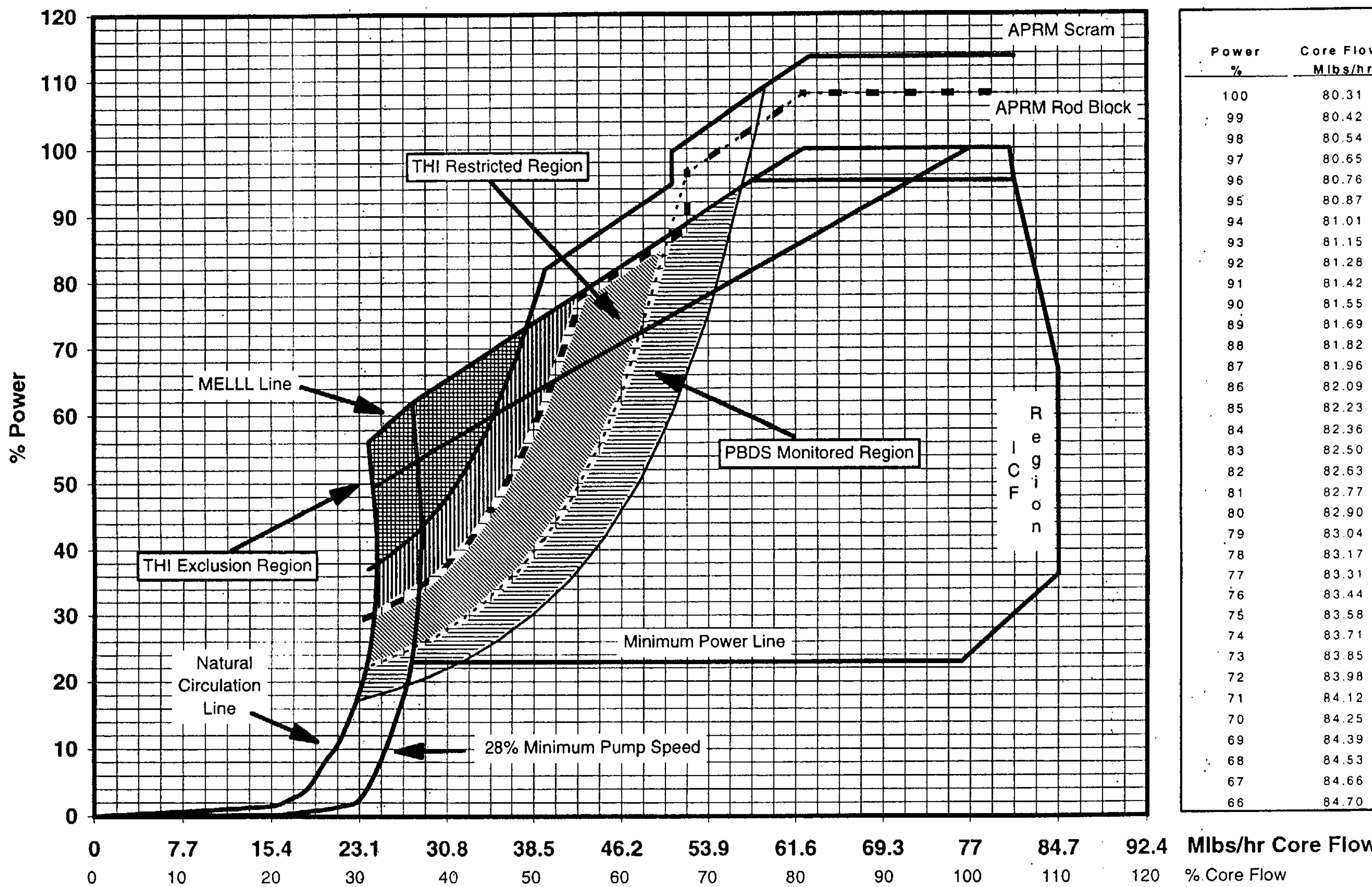
Figure 15
Power/Flow Map Stability Regions: Reduced TFW, Non-Setup



Power %	Core Flow, Mlbs/hr
100	80.31
99	80.42
98	80.54
97	80.65
96	80.76
95	80.87
94	81.01
93	81.15
92	81.28
91	81.42
90	81.55
89	81.69
88	81.82
87	81.96
86	82.09
85	82.23
84	82.36
83	82.50
82	82.63
81	82.77
80	82.90
79	83.04
78	83.17
77	83.31
76	83.44
75	83.58
74	83.71
73	83.85
72	83.98
71	84.12
70	84.25
69	84.39
68	84.53
67	84.66
66	84.70

This Figure supports Technical Specifications 3.2.3, 3.3.1.1 and 3.3.1.3 and the Technical Requirements Manual Specifications 3.2 and 3.3

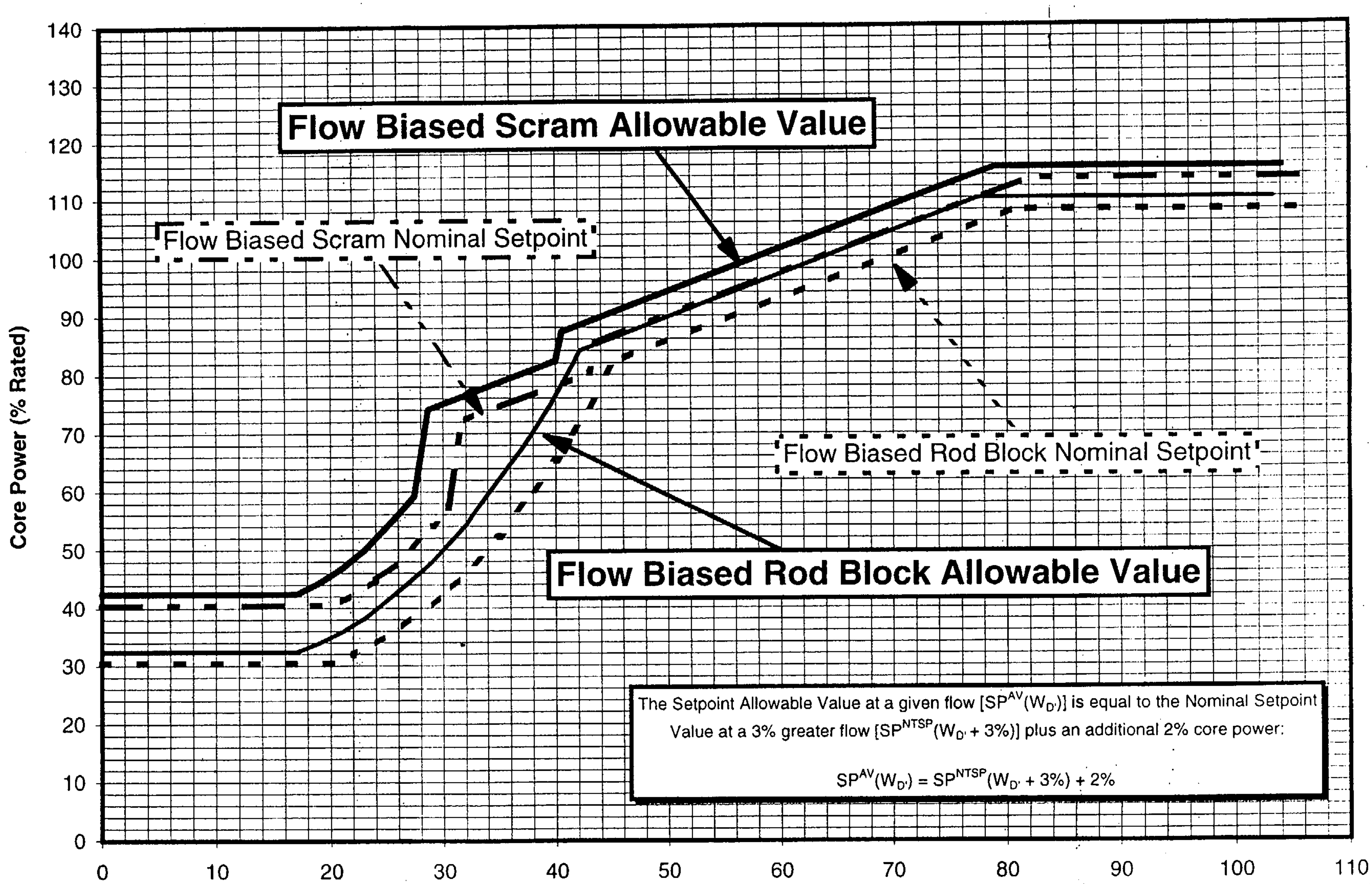
Figure 16
Power/Flow Map Stability Regions:
Reduced TFW, Setup



Power %	Core Flow, Mlbs/hr
100	80.31
99	80.42
98	80.54
97	80.65
96	80.76
95	80.87
94	81.01
93	81.15
92	81.28
91	81.42
90	81.55
89	81.69
88	81.82
87	81.96
86	82.09
85	82.23
84	82.36
83	82.50
82	82.63
81	82.77
80	82.90
79	83.04
78	83.17
77	83.31
76	83.44
75	83.58
74	83.71
73	83.85
72	83.98
71	84.12
70	84.25
69	84.39
68	84.53
67	84.66
66	84.70

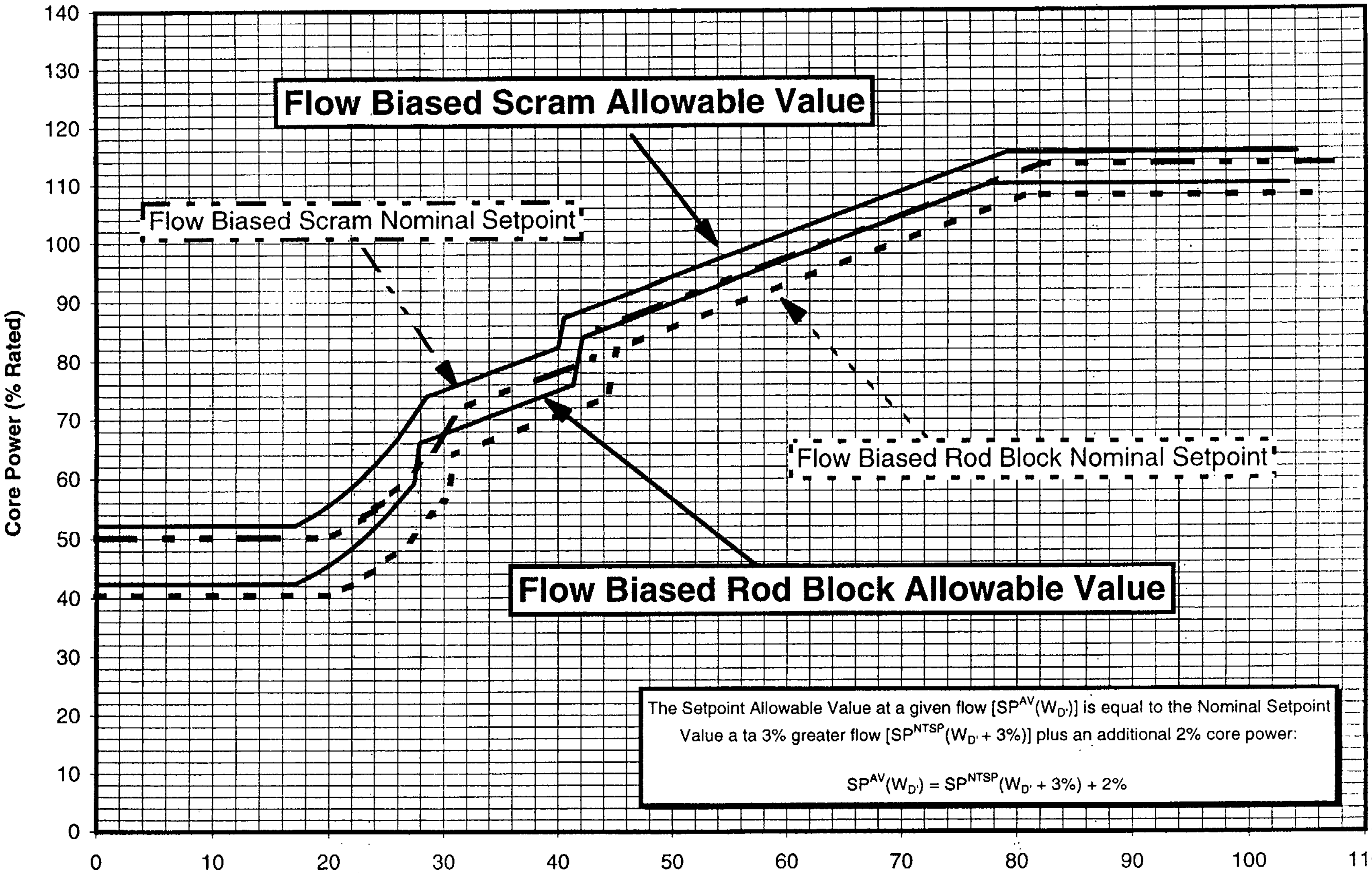
This Figure supports Technical Specifications 3.2.3, 3.3.1.1 and 3.3.1.3 and the Technical Requirements Manual Specifications 3.2 and 3.3

Figure 17
E1A Setpoint Allowable Values versus Aligned Drive Flow: Normal TFW, Non-Setup



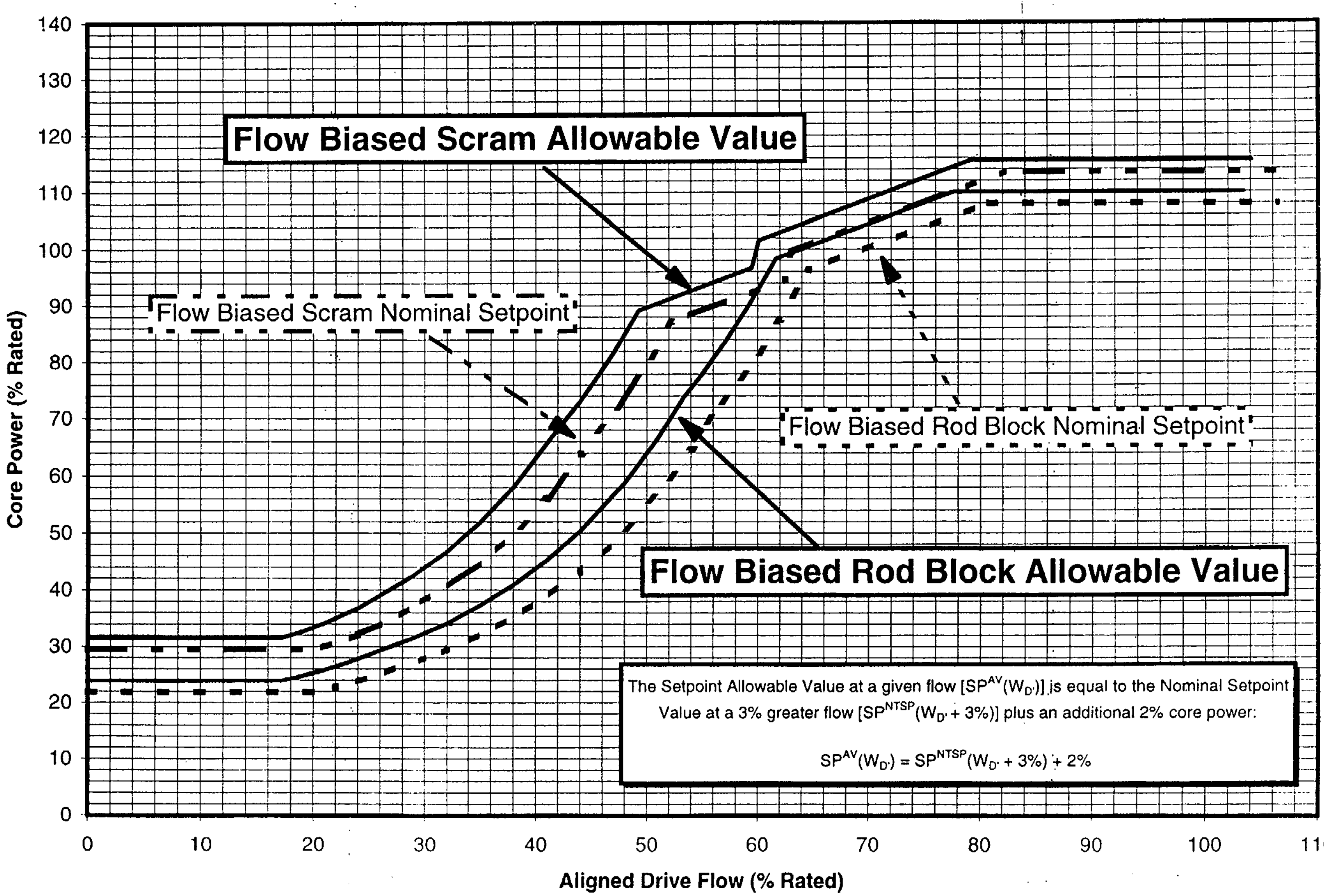
This Figure supports Technical Specification 3.3.1.1 and the Technical Requirements Manual Specifications 3.2 and 3.3

Figure 18
E1A Setpoint Allowable Values versus Aligned Drive Flow: Normal TFW, Setup



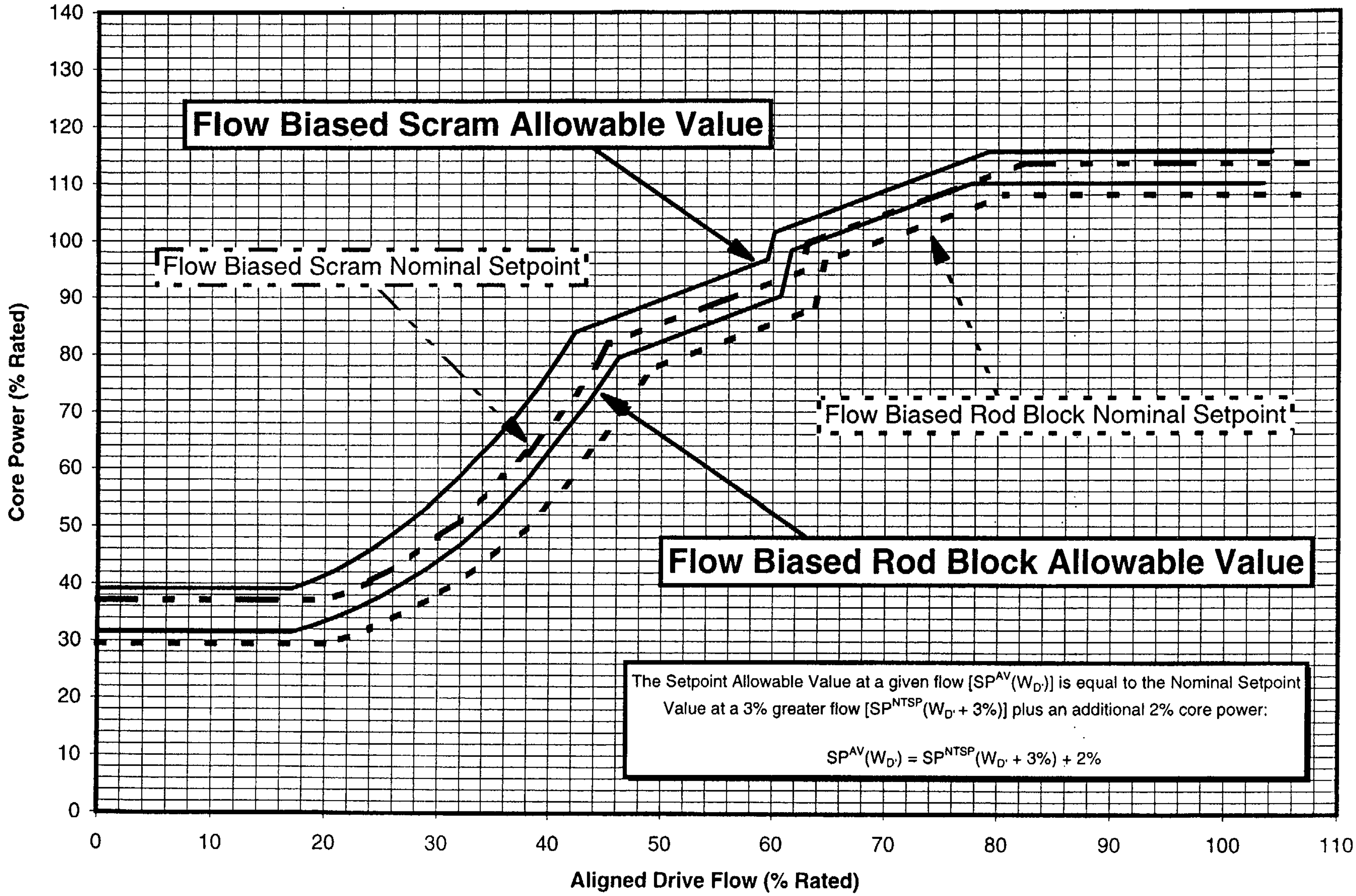
This Figure supports Technical Specification 3.3.1.1 and the Technical Requirements Manual Specifications 3.2 and 3.3

Figure 19
E1A Setpoint Allowable Values versus Aligned Drive Flow: Reduced TFW, Non-Setup



This Figure supports Technical Specification 3.3.1.1 and the Technical Requirements Manual Specifications 3.2 and 3.3

Figure 20
E1A Setpoint Allowable Values versus Aligned Drive Flow: Reduced TFW, Setup



This Figure supports Technical Specification 3.3.1.1 and the Technical Requirements Manual Specifications 3.2 and 3.3

ENCLOSURE 2

BRUNSWICK STEAM ELECTRIC PLANT, UNIT NO. 2
DOCKET NO. 50-324/LICENSE NO. DPR-62
TRANSMITTAL OF REVISIONS TO THE CORE OPERATING LIMITS REPORT AND SUPPLEMENTAL RELOAD LICENSING REPORT

J11-03412SRLR, Revision 1,
Supplemental Reload Licensing Report
for
Brunswick Steam Electric Plant Unit 2 Reload 13 Cycle 14

BRUNSWICK UNIT 2, CYCLE 14

CORE OPERATING LIMITS REPORT

February 2000

Prepared By: COPY Thomas M. Dresser **Date:** 2/10/00
Thomas M. Dresser

Approved By: COPY George E. Smith **Date:** 2/10/00
George E. Smith
Superintendent
BWR Fuel Engineering

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Single Loop Operation

Brunswick Unit 2, Cycle 14 may operate over the entire MEOD range with Single recirculation Loop Operation (SLO) as permitted by TS 3.4.1 with applicable limits specified in the COLR for TS LCO's 3.2.1, 3.2.2 and 3.3.1.1:

LCO 3.2.1, Average Planar Linear Heat Generation Rate (APLHGR) Limits: per Reference 1 and Figures 9 and 10, the APLHGR Limits include a SLO limitation of 0.8 on the MAPLHGR(F) and MAPLHGR(P) multipliers.

LCO 3.2.2, Minimum Critical Power Ratio (MCPR) Limits: per Reference 1, Table 1 and Figures 11, 11a and 12, the MCPR limits presented apply to SLO without modification.

LCO 3.3.1.1, Reactor Protection System Instrumentation Function 2.b (Average Power Range Monitors Flow Biased Simulated Thermal Power - High) Allowable Value: per Reference 1 and the THI E1A STABILITY SOLUTION, these limits apply to SLO without modification.

Inoperable Main Turbine Bypass System

Brunswick Unit 2, Cycle 14 may operate with an inoperable Main Turbine Bypass System in accordance with TS 3.7.6 with applicable limits specified in the COLR for TS LCO 3.2.1 and 3.2.2. Three or more bypass valves inoperable renders the System inoperable, although the Turbine Bypass Out-of-Service (TBPOOS) analysis supports operation with all bypass valves inoperable for the entire MEOD range and up to 110°F rated equivalent feedwater temperature reduction. The system response time assumed by the safety analyses from event initiation to start of bypass valve opening is 0.10 seconds, with at least 64% bypass flow achieved in 0.30 seconds. The applicable limits are as follows:

LCO 3.2.1, Average Planar Linear Heat Generation Rate (APLHGR) Limits: in accordance with Reference 1 as shown in Figure 10, TBPOOS requires a reduction in the MAPLGHR(P) limits between 25% and 30% power.

LCO 3.2.2, Minimum Critical Power Ratio (MCPR) Limits: in accordance with Reference 1, TBPOOS requires an increase in the MCPR(P) multiplier between 25% and 30% power, as shown in Figure 12. TBPOOS also requires increased MCPR limits, included in Table 1.

APLHGR Limits

The limiting APLHGR value for the most limiting lattice (excluding natural uranium) of each fuel type as a function of planar average exposure is given in Figures 1 through 7. These values were determined with the SAFER/GESTR LOCA methodology described in GESTAR-II (Reference 2). Figures 1 through 7 are to be used only when hand calculations are required as specified in the bases for TS 3.2.1. Hand calculated results may not match a POWERPLEX calculation since normal monitoring of the APLHGR limits with POWERPLEX uses the complete set of lattices for each fuel type provided in Reference 3.

The core flow and core power adjustment factors for use in TS 3.2.1 are presented in Figures 9 and 10. For any given flow/power state, the minimum of MAPLHGR(F) determined from Figure 9 and MAPLHGR(P) determined from Figure 10 is used to determine the governing limit.

The E1A Stability Solution provides for distinct Flow-biased Scram and Rod Block setpoints for normal and reduced feedwater temperature conditions ("normal" and "alternate" setpoints) because the core is more susceptible to instabilities with decreasing feedwater temperature. Normal setpoints (Figures 13, 14, 17, 18) are to be used below 30% power or when feedwater temperature is within 50°F rated equivalent of nominal. Alternate setpoints (Figures 15, 16 19, 20) are to be used above 30% power when feedwater is reduced by more than 50°F rated equivalent (50°F * (% power/100)$^{0.385}$) in accordance with 2OP-32.

References

1) BNP Design Calculation 2B21-0554; "Preparation of the B2C14 Core Operating Limits Report," Revision 1, February 2000.

2) NEDE-24011-P-A; "General Electric Standard Application for Reactor Fuel," (latest approved version).

3) NEDC-31624P, "Loss-of-Coolant Accident Analysis Report for Brunswick Steam Electric Plant Unit 2 Reload 13 Cycle 14," Supplement 2, Revision 6, February 1999.

4) EMF-2168(P), "Brunswick ATRIUM-10 Lead Qualification Assemblies Safety Analysis," Revision 0, March 1999.

ENCLOSURE 2

BRUNSWICK STEAM ELECTRIC PLANT, UNIT NO. 2
DOCKET NO. 50-324/LICENSE NO. DPR-62
TRANSMITTAL OF REVISIONS TO THE CORE OPERATING LIMITS REPORT AND
SUPPLEMENTAL RELOAD LICENSING REPORT

Supplemental Reload Licensing Report
for Brunswick Steam Electric Plant Unit 2 Reload 13, Cycle 14,
J11-03412SRLR, Revision 1,
February 2000

Global Nuclear Fuel

A Joint Venture of GE, Toshiba, & Hitachi

J11-03412SRLR
Revision 1
Class I
February 2000

J11-03412SRLR, Rev. 1

Supplemental Reload Licensing Report for Brunswick Steam Electric Plant Unit 2 Reload 13 Cycle 14

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J11-03412SRLR
Revision 1
Class I
February 2000

J11-03412SRLR, Rev. 1

Supplemental Reload Licensing Report

for

Brunswick Steam Electric Plant Unit 2

Reload 13 Cycle 14

Approved G.A. Watford, Manager
Nuclear Fuel Engineering

Approved W.H. Hetzel
Fuel Project Manager

Important Notice Regarding

Contents of This Report

Please Read Carefully

This report was prepared by Global Nuclear Fuel – Americas, LLC (GNF) solely for Carolina Power and Light Company (CP&L) for CP&L's use in defining operating limits for the Brunswick Steam Electric Plant Unit 2. The information contained in this report is believed by GNF to be an accurate and true representation of the facts known or obtained or provided to GNF at the time this report was prepared.

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Acknowledgement

The engineering and reload licensing analyses, which form the technical basis of this Supplemental Reload Licensing Report, were performed by G.M. Baka, H.M. Schrum and P. Wei. The Supplemental Reload Licensing Report was prepared by G.M. Baka. This document has been verified by D.P. Stier. Revision 1, of the Supplemental Reload Licensing Report was prepared by R.N. Anderson and verified by F.T. Bolger.

The basis for this report is *General Electric Standard Application for Reactor Fuel*, NEDE-24011-P-A-13, August 1996; and the U.S. Supplement, NEDE-24011-P-A-13-US, August 1996.

1. Plant-unique Items

Appendix A: Analysis Conditions
Appendix B: Main Steamline Isolation Valve Out of Service (MSIVOOS)
Appendix C: Decrease in Core Coolant Temperature Events
Appendix D: Feedwater Temperature Reduction (FWTR)
Appendix E: Maximum Extended Operation Domain (MEOD)
Appendix F: Turbine Bypass Out of Service (TBPOOS)
Appendix G: 8 of 10 Turbine Bypass Valves In Service

2. Reload Fuel Bundles [1]

Fuel Type	Cycle Loaded	Number
Irradiated:		
GE13-P9DTB363-11GZ1-100T-146-T (GE13)	12	58
GE13-P9DTB363-11GZ-100T-146-T (GE13)	12	118
GE13-P9DTB395-12G5.0-100T-146-T (GE13)	13	80
GE13-P9DTB393-4G6.0/9G5.0-100T-146-T (GE13)	13	104
New:		
GE13-P9DTB403-5G6.0/7G5.0-100T-146-T (GE13)	14	64
GE13-P9DTB403-7G6.0/7G5.0-100T-146-T (GE13)	14	136
Total		560

[1] The Cycle 14 core will contain four (4) lead qualification assemblies (LQAs) from Siemens. These were modeled as fresh GE13 bundles. All licensing implications of these LQAs will be handled by CP&L.

3. Reference Core Loading Pattern [2]

Nominal previous cycle core average exposure at end of cycle:	29056 MWd/MT (26359 MWd/ST)
Minimum previous cycle core average exposure at end of cycle from cold shutdown considerations:	28661 MWd/MT (26001 MWd/ST)
Assumed reload cycle core average exposure at beginning of cycle:	15205 MWd/MT (13794 MWd/ST)
Assumed reload cycle core average exposure at end of cycle:	31605 MWd/MT (28672 MWd/ST)
Reference core loadihg pattern:	Figure 1

4. Calculated Core Effective Multiplication and Control System Worth - No Voids, 20°C

Beginning of Cycle, $k_{effective}$	
Uncontrolled	1.111
Fully controlled	0.958
Strongest control rod out	0.987
R, Maximum increase in cold core reactivity with exposure into cycle, Δk	0.000

5. Standby Liquid Control System Shutdown Capability

Boron (ppm) (at 20°C)	Shutdown Margin (Δk) (at 20°C, Xenon Free)
660	0.031

6. Reload Unique GETAB Anticipated Operational Occurrences (AOO) Analysis Initial Condition Parameters

Exposure: BOC14 to EOC14-2205 MWd/MT (2000 MWd/ST) with ICF							
	Peaking Factors						
Fuel Design	**Local**	**Radial**	**Axial**	**R-Factor**	**Bundle Power (MWt)**	**Bundle Flow (1000 lb/hr)**	**Initial MCPR**
GE13	1.45	1.47	1.41	1.020	6.536	112.3	1.34

[2] The previous cycle core average exposure at beginning of cycle is 15417 MWd/MT (13986 MWd/ST).

Exposure: EOC14-2205 MWd/MT (2000 MWd/ST) to EOC14 with ICF							
	Peaking Factors						
Fuel Design	Local	Radial	Axial	R-Factor	Bundle Power (MWt)	Bundle Flow (1000 lb/hr)	Initial MCPR
GE13	1.45	1.52	1.19	1.020	6.764	110.2	1.35

Exposure: BOC14 to EOC14 with TBPOOS							
	Peaking Factors						
Fuel Design	Local	Radial	Axial	R-Factor	Bundle Power (MWt)	Bundle Flow (1000 lb/hr)	Initial MCPR
GE13	1.45	1.50	1.19	1.020	6.662	110.8	1.38

7. Selected Margin Improvement Options

Recirculation pump trip:	No
Rod withdrawal limiter:	No
Thermal power monitor:	Yes
Improved scram time:	Yes (ODYN Option B)
Measured scram time:	No
Exposure dependent limits:	Yes
Exposure points analyzed:	2 (EOC14-2205 MWd/MT and EOC14)

8. Operating Flexibility Options

Single-loop operation:	Yes
Load line limit:	Yes
Extended load line limit:	Yes
Maximum extended load line limit:	Yes
Increased core flow throughout cycle:	Yes
Flow point analyzed:	104.5 %

Increased core flow at EOC:	Yes
Feedwater temperature reduction throughout cycle:	Yes
Temperature reduction:	110.3°F
Final feedwater temperature reduction:	Yes
ARTS Program:	Yes
Maximum extended operating domain:	Yes
Moisture separator reheater OOS:	No
Turbine bypass system OOS:	Yes
Safety/relief valves OOS: (credit taken for 9 of 11 valves)	Yes (Additional evaluations are required to support this option.)
ADS OOS:	Yes (2 valves OOS)
EOC RPT OOS:	No
Main steam isolation valves OOS:	Yes

9. Core-wide AOO Analysis Results

Methods used: GEMINI; GEXL-PLUS

Exposure range: BOC14 to EOC14-2205 MWd/MT (2000 MWd/ST) with ICF				
			Uncorrected ΔCPR	
Event	**Flux (%NBR)**	**Q/A (%NBR)**	**GE13**	**Fig.**
Load Reject w/o Bypass	424	120	0.25	2

Exposure range: EOC14-2205 MWd/MT (2000 MWd/ST) to EOC14 with ICF				
			Uncorrected ΔCPR	
Event	**Flux (%NBR)**	**Q/A (%NBR)**	**GE13**	**Fig.**
Load Reject w/o Bypass	338	118	0.27	3

Exposure range: BOC14 to EOC14 with TBPOOS				
			Uncorrected ΔCPR	
Event	Flux (%NBR)	Q/A (%NBR)	GE13	Fig.
FW Controller Failure	327	123	0.29	4

10. Local Rod Withdrawal Error (With Limiting Instrument Failure) AOO Summary

The rod withdrawal error (RWE) event in the maximum extended operating domain was originally analyzed in the GE BWR Licensing Report, *Maximum Extended Operating Domain Analysis for Brunswick Steam Electric Plant*, NEDC-31654P, February 1989. The MCPR for rod withdrawal error is bounded by the operating limit MCPRs presented in Section 11 of this report for RBM setpoints shown in Table 10-5(a) or 10-5(b) of NEDC-31654P. Additionally, the RBM operability requirements specified in Section 10.5 of NEDC-31654P have been evaluated and shown to be sufficient to ensure that the Safety Limit MCPR and cladding 1% plastic strain criteria will not be exceeded in the event of an unblocked RWE event.

11. Cycle MCPR Values [3]

In agreement with commitments to the NRC (letter from M. A. Smith to the Document Control Desk, *10CFR Part 21, Reportable Condition, Safety Limit MCPR Evaluation*, May 24, 1996) a cycle-specific Safety Limit MCPR calculation was performed, and has been reported in both the Safety Limit MCPR and the Operating Limit MCPR shown below. The cycle-specific single loop operation Safety Limit was calculated to be 0.01 greater than the two loop Safety Limit MCPR as shown below. This cycle specific SLMCPR was determined using the analysis basis documented in GESTAR with the following exceptions:

1. The reference core loading was analyzed.
2. The actual bundle parameters (e.g., local peaking) were used.
3. The full cycle exposure range was analyzed.

Safety limit: 1.09

Single loop operation safety limit: 1.10

[3] The Operating Limit MCPRs for two loop operation (TLO) bound the Operating Limit MCPRs for single loop operation (SLO); therefore, the Operating Limit MCPRs need not be changed for SLO.

Non-pressurization events:

Exposure range: BOC14 to EOC14	
	GE13
Fuel Loading Error (misoriented)	1.29
Fuel Loading Error (mislocated)	1.22
Rod Withdrawal Error (for RBM setpoint of 108%)	1.23

Pressurization events:

Exposure range: BOC14 to EOC14-2205 MWd/MT (2000 MWd/ST) with ICF [4] Exposure point: EOC14-2205 MWd/MT (2000 MWd/ST)		
	Option A	**Option B**
	GE13	**GE13**
Load Reject w/o Bypass	1.39	1.34

Exposure range: EOC14-2205 MWd/MT (2000 MWd/ST) to EOC14 with ICF [5] Exposure point: EOC14		
	Option A	**Option B**
	GE13	**GE13**
Load Reject w/o Bypass	1.46	1.38

Exposure range: BOC14 to EOC14 with TBPOOS [6] Exposure point: EOC14		
	Option A	**Option B**
	GE13	**GE13**
FW Controller Failure	1.48	1.40

[4] The ICF Operating Limits for the exposure range of BOC14 to EOC14-2205 MWd/MT (2000 MWd/ST) bound the Operating Limits for the following domains: MELLL, ICF and FWTR, MSIVOOS and ICF.
[5] The ICF Operating Limits for the exposure range of EOC14-2205 MWd/MT (2000 MWd/ST) to EOC14 bound the operating Limits for the following domains: MELLL, ICF and FWTR, MSIVOOS and ICF.
[6] The TBPOOS Operating Limits for the exposure range of BOC14 to EOC14 bound the Operating Limits for the TBPOOS and FWTR domain.

12. Overpressurization Analysis Summary

Event	Psl (psig)	Pv (psig)	Plant Response
MSIV Closure (Flux Scram)	1289	1323	Figure 5

13. Loading Error Results

Variable water gap misoriented bundle analysis: Yes [7]

Misoriented Fuel Bundle	ΔCPR
GE13-P9DTB395-12G5.0-100T-146-T (GE13)	0.19
GE13-P9DTB393-4G6.0/9G5.0-100T-146-T (GE13)	0.20
GE13-P9DTB403-7G6.0/7G5.0-100T-146-T (GE13)	0.10
GE13-P9DTB403-5G6.0/7G5.0-100T-146-T (GE13)	0.06

Mislocated Fuel Bundle	ΔCPR
Fuel Loading Error (mislocated)	0.13

14. Control Rod Drop Analysis Results

This is a banked position withdrawal sequence plant, therefore, the control rod drop accident analysis is not required. NRC approval is documented in NEDE-24011-P-A-US.

15. Stability Analysis Results

Brunswick Unit 2 Cycle 13, Reactor Stability Long-Term Solution Enhanced Option I-A, Stability Region Boundary Generation and Validation, GENE-A13-00367-58 documents the Enhanced Option I-A (EIA) stability region boundaries for Brunswick Unit 2 Cycle 13 and the analysis associated with their generation and validation. Reload validation of these stability region boundaries has been performed in accordance with NEDO-32339, Revision 1, *Reactor Stability Long Term Solution: Enhanced Option I-A*. The Reload Validation Matrix confirms best-estimate code boundary validation stability criteria. The results are shown in Figure 6.

[7] Includes a 0.02 penalty due to variable water gap R-factor uncertainty. .

16. Loss-of-Coolant Accident Results

LOCA method used: SAFER/GESTR-LOCA

The GE8x8EB LOCA analysis results, presented in Sections 5 and 6 of *Brunswick Steam Electric Plant Units 1 and 2 SAFER/GESTR-LOCA Loss-of-Coolant Accident Analysis*, NEDC-31624P, Revision 2, July 1990, yielded a licensing basis peak clad temperature of 1537°F, a peak local oxidation fraction of <0.31%, and a core-wide metal-water reaction of 0.036%.

An additional LOCA analysis was performed for the GE13 fuel type. The results, presented in *Brunswick Steam Electric Plant Units 1 and 2 SAFER/GESTR-LOCA Loss-of-Coolant Accident Analysis: Application to GE13 Fuel*, NEDC-31624P, Supplement 3, Revision 0, January 1996, indicate that the GE13 fuel is bounded by the results from GE8x8EB fuel.

This analysis did not establish new Licensing Basis PCTs for the fuels in BSEP-2. Therefore, the following changes and error effects must be added to the Licensing Basis PCT of 1537°F: 10°F for Bottom Head Drain (see *Reporting of Changes and Errors in ECCS Evaluation Models*, MFN-020-96, February 20, 1996) and 50°F for sensitivity to small input parameter changes for BWR/4 plants with LPCI injection into the lower plenum (see *Reporting of Changes and Errors in ECCS Evaluation Models*, MFN-090-93, June 30, 1993). The corrected Licensing Basis PCT is 1597°F.

A single loop operation (SLO) MAPLHGR multiplier of 0.80 is applicable to GE13 fuel types. Therefore, the power- and flow-dependent MAPLHGR adjustment factors identified in Figures 4-2 and 4-4 of *Maximum Extended Operating Domain Analysis for the Brunswick Steam Electric Plant*, NEDC-31654P, Class III (GE Nuclear Energy Proprietary), February 1989, should be used with the limitation that no multiplier greater than 0.80 is used during SLO.

The most and least limiting MAPLHGRs for the new GE13 fuel designs are as follows:

16. Loss-of-Coolant Accident Results (cont.)

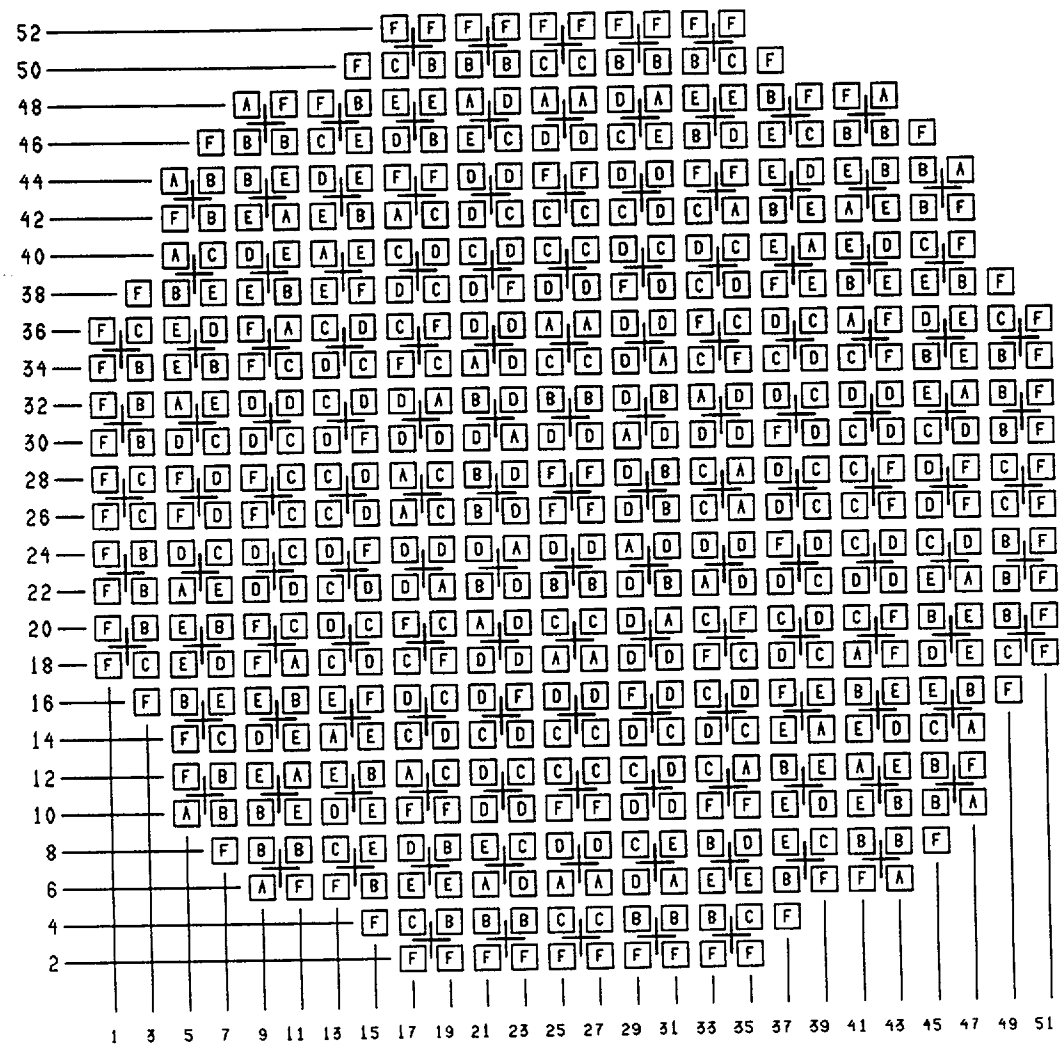
Bundle Type: GE13-P9DTB403-7G6.0/7G5.0-100T-146-T

Average Planar Exposure		MAPLHGR (kw/ft)	
(GWd/ST)	(GWd/MT)	Most Limiting	Least Limiting
0.00	0.00	10.44	10.44
0.20	0.22	10.51	10.51
1.00	1.10	10.61	10.63
2.00	2.20	10.74	10.77
3.00	3.31	10.88	10.93
4.00	4.41	11.02	11.09
5.00	5.51	11.17	11.26
6.00	6.61	11.32	11.43
7.00	7.72	11.48	11.59
8.00	8.82	11.62	11.74
9.00	9.92	11.73	11.89
10.00	11.02	11.85	12.04
12.50	13.78	11.86	12.16
15.00	16.53	11.86	12.21
17.50	19.29	11.76	12.06
20.00	22.05	11.54	11.80
25.00	27.56	11.02	11.25
30.00	33.07	10.49	10.70
35.00	38.58	9.85	10.01
40.00	44.09	9.13	9.26
45.00	49.60	8.43	8.52
50.00	55.12	7.73	7.81
55.00	60.63	7.03	7.14
58.33	64.29	6.56	6.61
59.06	65.11	--	6.49

16. Loss-of-Coolant Accident Results (cont.)

Bundle Type: GE13-P9DTB403-5G6.0/7G5.0-100T-146-T

Average Planar Exposure		MAPLHGR (kw/ft)	
(GWd/ST)	(GWd/MT)	Most Limiting	Least Limiting
0.00	0.00	10.65	10.73
0.20	0.22	10.72	10.79
1.00	1.10	10.85	10.88
2.00	2.20	11.00	11.03
3.00	3.31	11.12	11.21
4.00	4.41	11.25	11.35
5.00	5.51	11.38	11.50
6.00	6.61	11.52	11.66
7.00	7.72	11.66	11.82
8.00	8.82	11.81	11.99
9.00	9.92	11.95	12.12
10.00	11.02	12.05	12.26
12.50	13.78	12.04	12.36
15.00	16.53	11.97	12.29
17.50	19.29	11.79	12.07
20.00	22.05	11.54	11.79
25.00	27.56	11.02	11.23
30.00	33.07	10.44	10.49
35.00	38.58	9.69	9.85
40.00	44.09	8.98	9.14
45.00	49.60	8.30	8.44
50.00	55.12	7.64	7.74
55.00	60.63	7.00	7.05
58.49	64.48	6.54	6.55
59.19	65.25	--	6.45



Fuel Type	
A=GE13-P9DTB363-11GZ1-100T-146-T (Cycle 12)	D=GE13-P9DTB403-7G6.0/7G5.0-100T-146-T (Cycle 14)
B=GE13-P9DTB395-12G5.0-100T-146-T (Cycle 13)	E=GE13-P9DTB403-5G6.0/7G5.0-100T-146-T (Cycle 14)
C=GE13-P9DTB393-4G6.0/9G5.0-100T-146-T (Cycle 13)	F=GE13-P9DTB363-11GZ-100T-146-T (Cycle 12)

Figure 1 Reference Core Loading Pattern

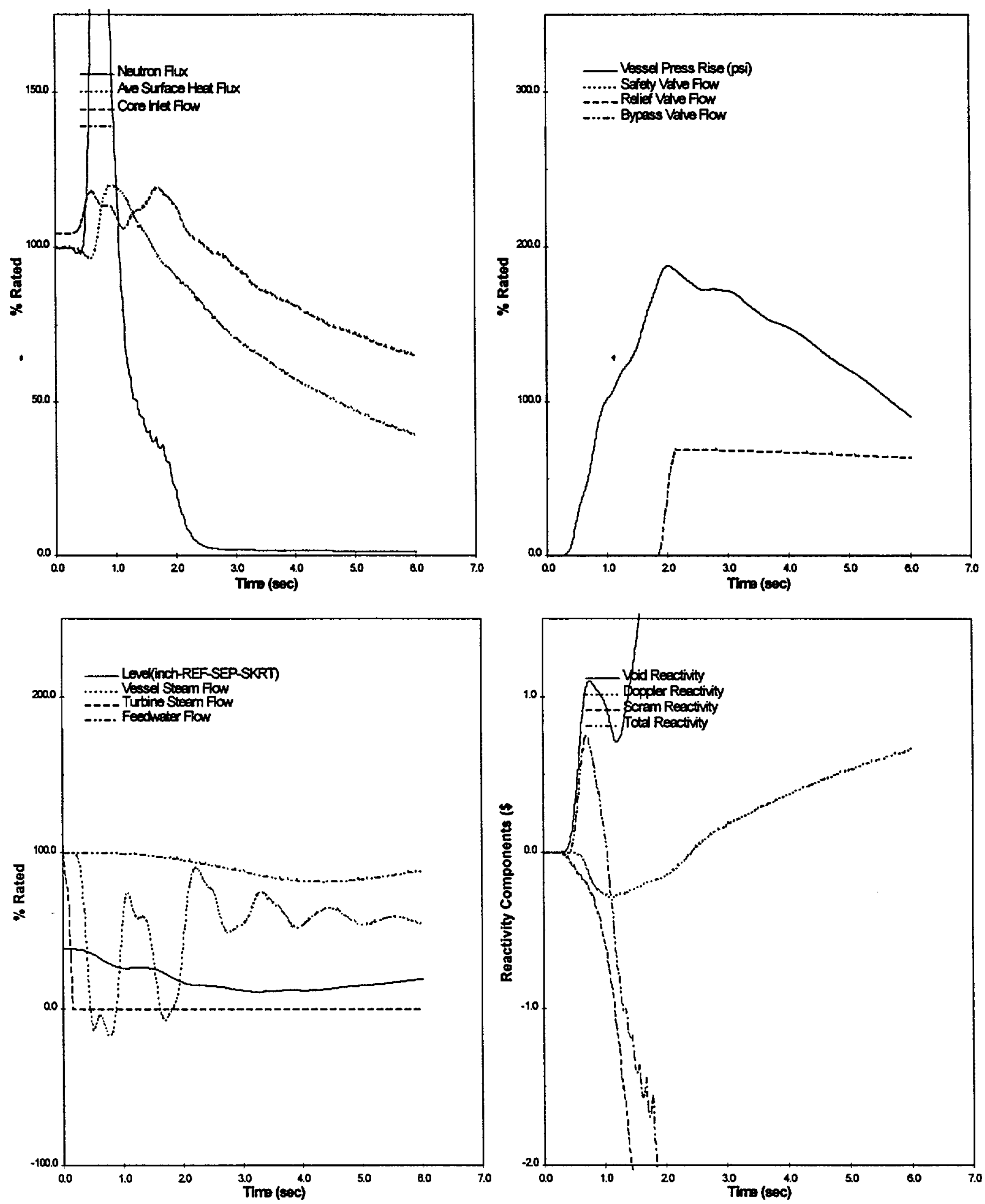


Figure 2 Plant Response to Load Reject w/o Bypass (BOC14 to EOC14-2205 MWd/MT (2000 MWd/ST) with ICF)

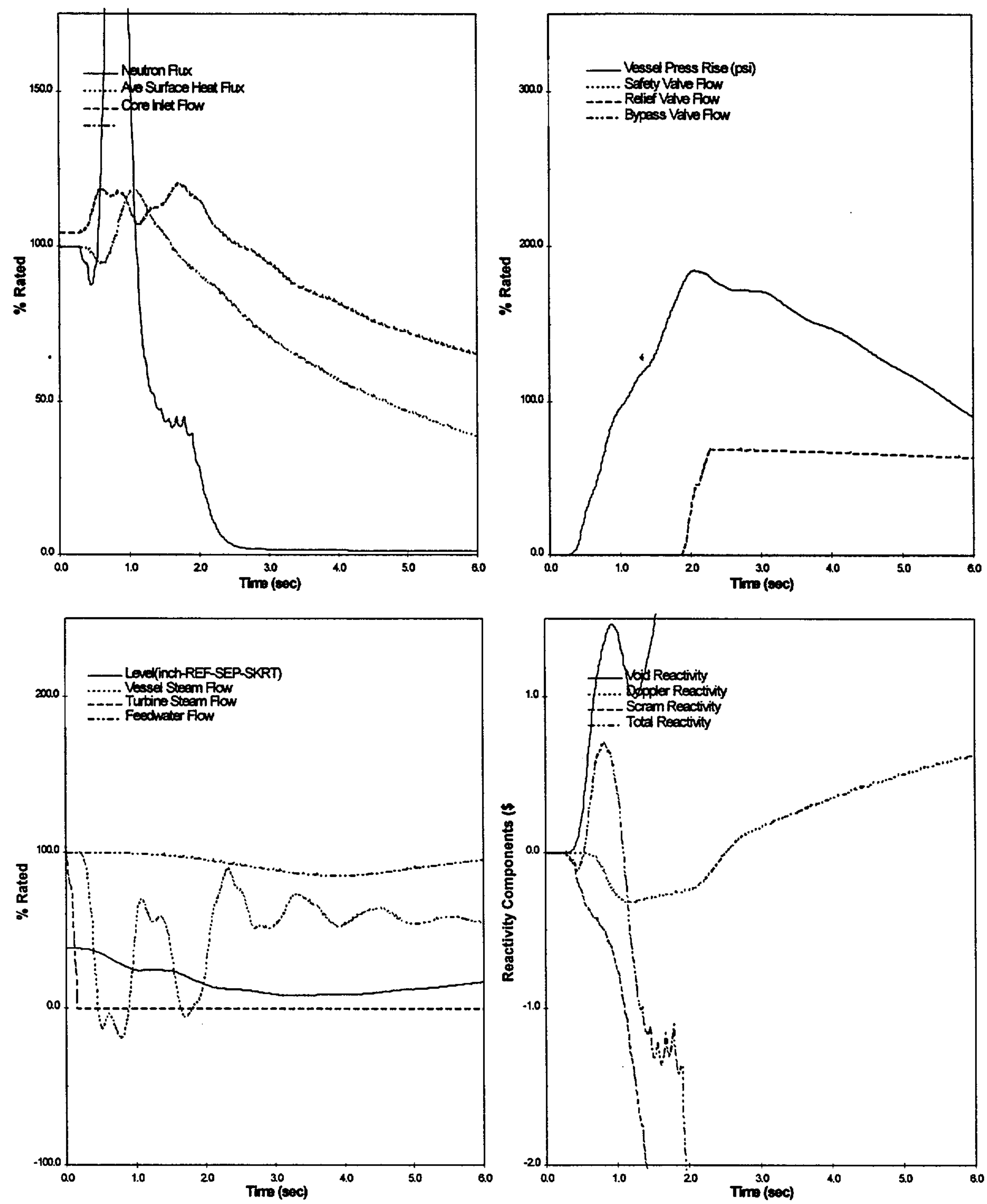


Figure 3 Plant Response to Load Reject w/o Bypass (EOC14-2205 MWd/MT (2000 MWd/ST) to EOC14 with ICF)

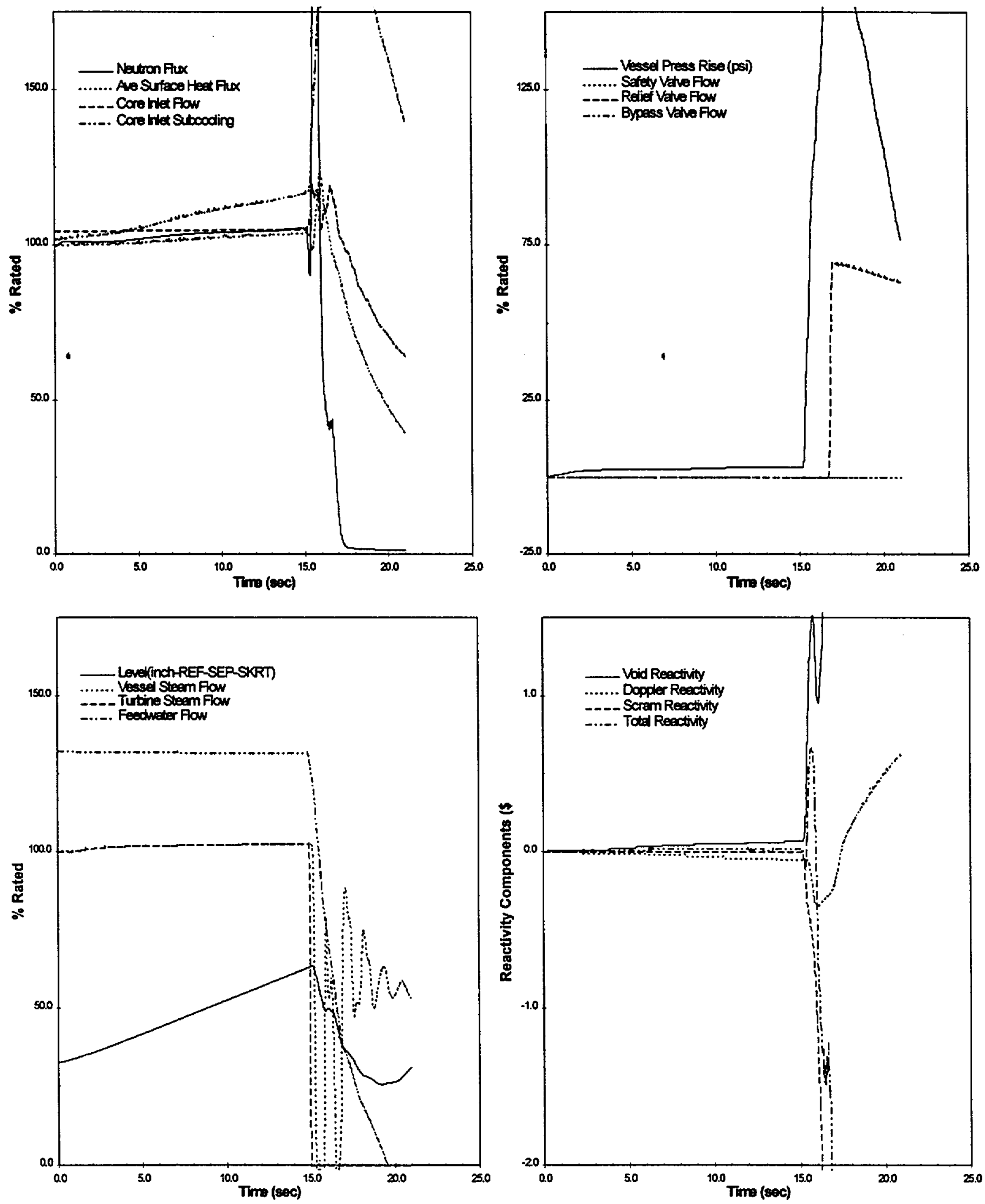


Figure 4 Plant Response to FW Controller Failure (BOC14 to EOC14 with TBPOOS)

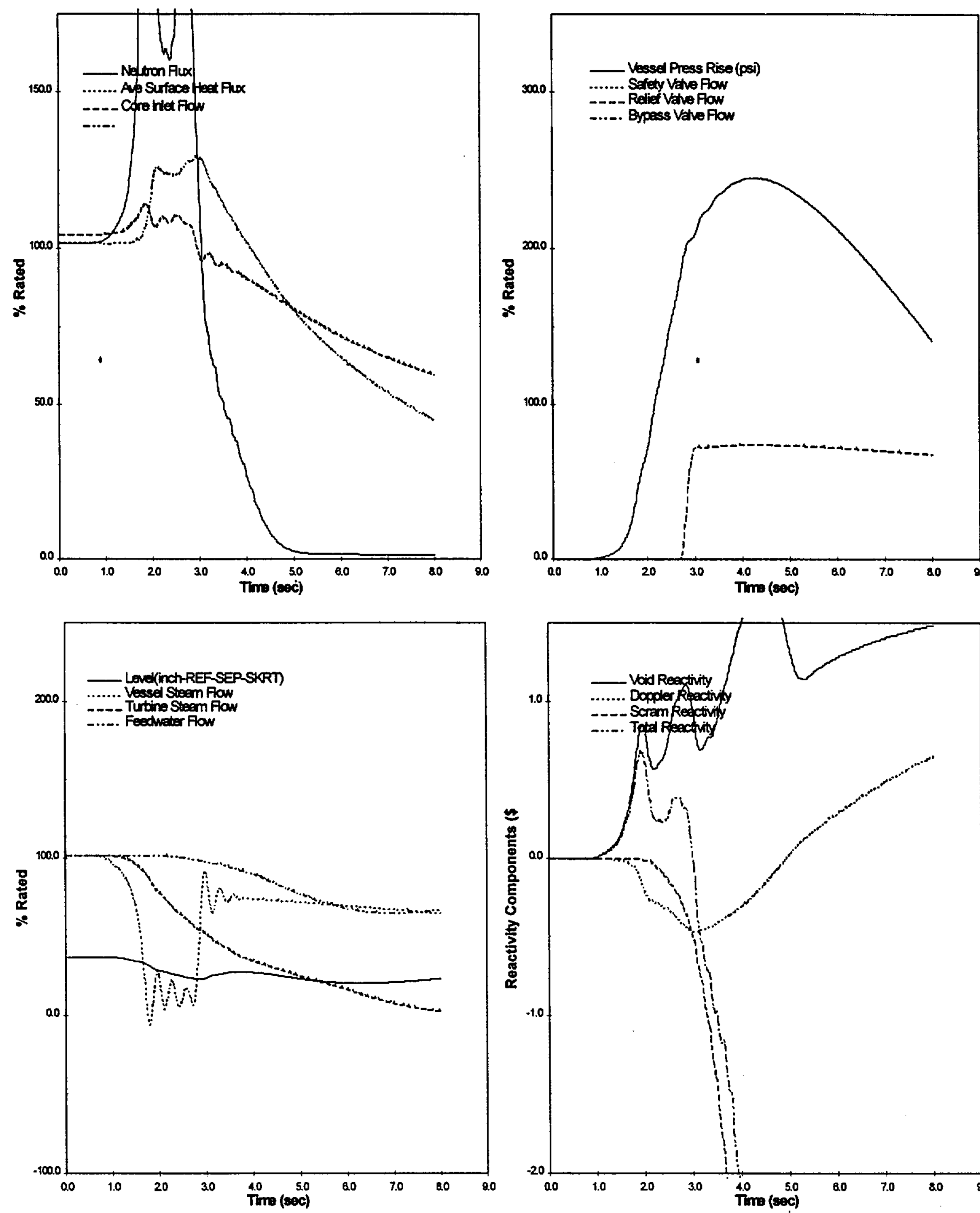


Figure 5 Plant Response to MSIV Closure (Flux Scram)

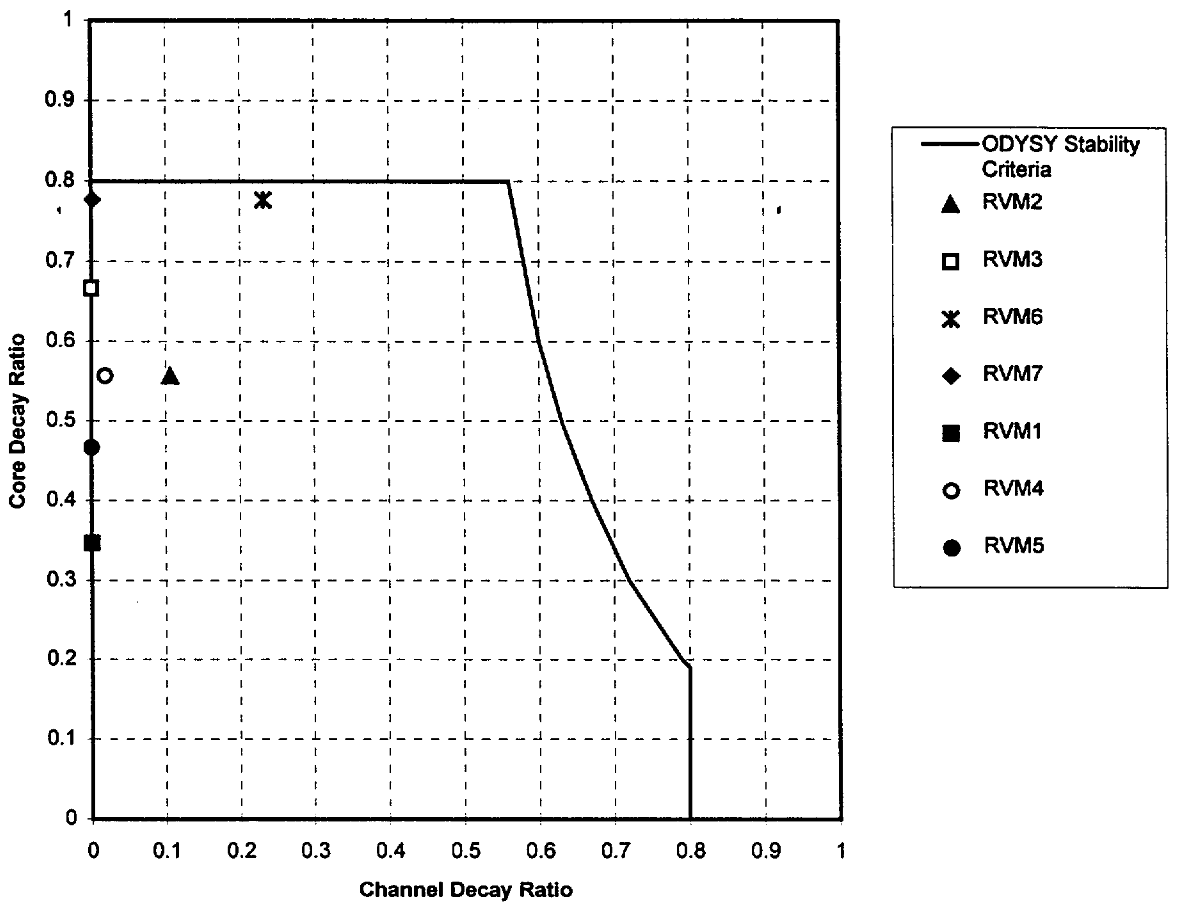


Figure 6 RVM Results versus ODYSY Stability Criteria

Appendix A
Analysis Conditions

To reflect actual plant parameters accurately, the values shown in Table A-1 were used this cycle.

Table A-1

	Analysis Value	
Parameter	**ICF**	**FWTR**
Thermal power, MWt	2558.0	2558.0
Core flow, Mlb/hr	80.5	80.5
Reactor pressure, psia	1060.9	1044.9
Inlet enthalpy, BTU/lb	530.7	517.5
Non-fuel power fraction	0.036	0.036
Steam flow, Mlb/hr	11.09	9.66
Dome pressure, psig	1030.0	1015.3
Turbine pressure, psig	985.4	981.2
No. of Safety/Relief Valves	9	9
Relief mode lowest setpoint, psig	1164.0	1164.0
Recirculation pump power source	on-site [8]	on-site [8]
Turbine control valve mode of operation	Partial arc	Partial arc

[8] Bounds operation with off-site power source for reload licensing events for Cycle 14.

Appendix B
Main Steamline Isolation Valve Out of Service (MSIVOOS)

Reference B-1 provided a basis for operation of the Brunswick Steam Electric Plant (BSEP) with one Main Steamline Isolation Valve Out of Service (MSIVOOS) (three steamline operation) and all S/RVs in service. For this mode of operation in BSEP Unit 2 throughout Cycle 14, the ICF operating limit MCPRs presented in Section 11 of this report are bounding and should be applied when operating in the MSIVOOS mode at any time during the cycle. The peak steamline and peak vessel pressures for the limiting overpressurization event (MSIV closure with flux scram) were not calculated for the MSIVOOS mode of operation. In this mode of operation it is required that all S/RVs be operational versus the assumed two S/RVs OOS for the events evaluated during normal plant operation. Previous cycles analyses have shown that the MSIV closure with flux scram, evaluated in the MSIVOOS mode, has resulted in the peak vessel pressure being reduced by more than 25 psi, when compared to the same case evaluated with all (four) steamlines operational.

Reference

B-1. *Main Steamline Isolation Valve Out of Service for the Brunswick Steam Electric Plant*, EAS-117-0987, GE Nuclear Energy, April 1988.

Appendix C
Decrease in Core Coolant Temperature Events

The Loss of Feedwater Heater (LFWH) event and the Inadvertent HPCI start-up event are the only cold water injection AOOs checked on a cycle-by-cycle basis.

The LFWH transient was last analyzed for Brunswick-1 Cycle 11 (a power uprate GE13 reload) and had a resulting ΔCPR of 0.12. The Brunswick-1 and Brunswick-2 plants are nearly identical and have identical licensing basis heat balance conditions. There is no difference in equipment performance in Brunswick-2 Cycle 14 as compared to Brunswick-1 Cycle 11 which indicates a need for a specific analysis. The results of the AOOs presented in Section 11 of this report sufficiently bound the expected results of the LFWH event. Therefore, the LFWH event is not limiting and analysis is not required.

In addition, the Inadvertent HPCI start-up event was shown to be bounded by the LFWH event in Brunswick-1 Cycle 11. No parameters in Brunswick-2 Cycle 14 differ so as to invalidate the Brunswick-1 Cycle 11 determination. Therefore, the Brunswick-1 Cycle 11 analysis is applicable to Brunswick-2 Cycle 14 and the Inadvertent HPCI transient is bounded by LFWH.

Appendix D
Feedwater Temperature Reduction (FWTR)

Reference D-1 provides the basis for operation of the Brunswick Steam Electric Plant (BSEP) with Feedwater Temperature Reduction (FWTR). The MCPR limits presented in Section 11 of this report are bounding and should be applied when operating with FWTR. The MCPR limits apply to operation up to the exposure attainable using Increased Core Flow with Final Feedwater Temperature Reduction (which for Cycle 14 is a core average exposure of 32442 MWd/MT). Previous analysis has shown that the FWCF event is most severe at ICF and FWTR. The analyses used to calculate FWTR limits were based on constant turbine pressure which bounds constant dome pressure.

Reference

D-1. *Feedwater Temperature Reduction with Maximum Extended Load Line Limit and Increased Core Flow for Brunswick Steam Electric Plant Units 1 and 2,* NEDC-32457P, Revision 1, December 1995.

Appendix E
Maximum Extended Operating Domain (MEOD)

Reference E-1 provided a basis for operation of the Brunswick Steam Electric Plant (BSEP) in the Maximum Extended Operating Domain (MEOD). Previous cycles have shown that these low flow conditions are bounded by ICF, therefore this domain was not analyzed for Cycle 14. Application of the GEXL-PLUS correlation to the reload fuel has been confirmed as required in reference E-1. The applicability of GE13 was addressed and found acceptable.

Reference

E-1. *Maximum Extended Operating Domain Analysis for Brunswick Steam Electric Plant,* NEDC-31654P, GE Nuclear Energy (Proprietary), February 1989.

Appendix F
Turbine Bypass Out Of Service (TBPOOS)

Reference F-1 provided a basis for operation of the Brunswick Steam Electric Plant (BSEP) with all Turbine Bypass Valves Out of Service (TBPOOS) and two S/RVs Out of Service (2 SRVOOS). Reference F-1 has been confirmed applicable to the operation of BSEP Unit 2 for Cycle 14. Section 11 of this report presents the MCPR limits for the modes of operation with TBPOOS.

Reference

F-1. *Turbine Bypass Out of Service Analysis for Carolina Power & Light Company's Brunswick Nuclear Plants Units 1 and 2,* NEDC-32813P, Revision 3, GE Nuclear Energy (Proprietary), June 1998.

Appendix G
8 of 10 Turbine Bypass Valves In Service

Reducing the number of turbine bypass valves in service, from 10 to 8, effects only the FW Controller Failure event. The FW Controller Failure is the only limiting pressurization transient that takes credit for the turbine bypass system. With all 10 turbine bypass valves operational, the system can pass 80% of rated steam flow. With 8 bypass valves in service, the capacity is reduced to 64%. This still represents a substantial capacity. Note that the turbine bypass capacity, in Brunswick 1, is approximately 24%, which is typical of most BWRs. The FWCF transient can potentially impact the Feedwater Temperature Reduction (FWTR) (see Appendix D) and the Maximum Extended Operating Domain (MEOD) (see Appendix E).

This reduction in turbine bypass capacity, to 64%, has only minor impact on the evaluation of the FW Controller Failure with FWTR. The FW Controller Failure (with 80% turbine bypass) is 0.16 lower in ΔCPR than the limiting event (LRNB with ICF). Even with the reduction to 64% turbine bypass capacity, substantial margin (estimated to be about 0.12) would be retained. The conclusions of Appendix D are not impacted, i.e., the MCPR limits of Section 11 are bounding and should be applied when operating with FWTR.

Likewise, this reduction in turbine bypass capacity has negligible impact on the FW Controller Failure, as it affects the applicability of the MEOD power dependent operating limits. This is because the MCPR(P) and MAPLHGR(p) functions, from above 30% (power at which the direct scram function, resulting from either a turbine trip of load rejection, is bypassed) to 100% power, were originally developed considering turbine bypass capacities of about 25%. In the range of 25% power to 30% power, there is no difference between 80% (all 10 turbine bypass valves in service) and 64% (8 turbine bypass valves in service). This results because the initial steam flow is less than 30% and as few as 4 turbine bypass valves would be sufficient to pass all of the steam.